AUGUST, 1941.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE

1380. Nuclei, radioactivity. R. FLEISCHMANN. *Phys. in regelmäss. Ber.*, **8,** 1, *pp.* 17–48, 1940. *In German.*—This report covers the period from the appearance of the previous report [Abstr. 4041 (1935)] till Nov., 1939. After explaining the abbreviated mode of notation for nuclear transformations the author deals with stable nuclei forming the initial material for the transformation, the properties of the particles and their production, methods used for identifying the rays produced, phenomena of transformation and artificial and natural radioactive nuclei. A table shows the elements arranged according to atomic number, number of neutrons and the atom. wts., indicating the frequency of the existence of stable nuclei and the different kinds of natural and artificial radioactivity. Finally, the methods are surveyed for the separation of isotopes. A Bibliography of 235 publications is given. R. N.

1381. Report on isotopes, 1940. S. FLÜGGE AND J. MATTAUCH. *Phys. Z.*, **42,** *pp.* 1–5, *Jan.* 1, 1941. *In German.*—The elements included in the table of the present report are *n*, H, He, Li, Be, B, C, N, O, F, Ne, Na, Mg, Al, Si, P, S, Cl, A, K, Ca, Sc, Ti, V, Fe, and the data comprise proton number Z, mass number A, neutron number $A - Z$, $(M - A) \times 10^4$ instead of the exact atomic masses, packing fraction $f = (M - A)/A \times 10^4$, mass defect, and, in the final column, the nuclear reactions and mass-spectrographic doublets forming the basis of the new calculations by the authors of the masses of the *light* nuclei. The work of Dempster and Graves utilized in the former report [Abstr. 1964 (1940)] still remains in force for the heavy nuclei. Included in the table are also the masses of the artificial radioactive nuclei in so far as they are obtainable from the nuclear reactions. A critical examination is made of the results of the investigations used for the data. H. G. S.

1382. Tracer isotopes in analytical chemistry. J. F. FLAGG AND E. O. WIIG. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 341–345, *May* 15, 1941.—

1383. Hypothesis of higher proton isobares. G. WENTZEL. *Helv. Phys. Acta*, **14,** 1, *pp.* 3–20, 1941. *In German.*—A discussion is given of the Heitler-Bhabha theory of proton states of higher charge and its effect on the problem of meson scattering. The requirement that the meson scattering be weak at a given magnitude of the nuclear forces puts a limitation on the choice of the proton-meson coupling. In the case that the coupling law possesses known simple properties an approx. process can be given, which depends on the fact that the mass difference of neighbouring proton isobares and the recoil energy shall be regarded as small. The calculation is carried out for a scalar meson field and also on the basis of 2 different coupling laws. One law leads to the result that the interaction between protons and mesons vanishes in the limit that the masses of the proton isobares are made equal. In this case the introduction of higher proton isobares is no improvement on the earlier theory of Yukawa. G. O. B.

1384. Structures of methyl borate and trimethyl triborine trioxane. Interatomic distances in boron compounds. S. H. BAUER AND J. Y. BEACH. *J. Amer. Chem. Soc.*, **63,** *pp.* 1394–1403, *May*, 1941.—An electron diffraction investigation of the vapours of methyl borate and of trimethyl triborine trioxane led to the following structures for these compounds. Methyl borate: Planar BO_3 group, with B–O = 1·38 ± 0·02 Å; O–C = 1·43 ± 0·03 Å; and the B–O–C angle equal to 113 ± 3°. Rotation of the methoxy groups about the B–O bonds is indicated. Trimethyl triborine trioxane: Planar 6-membered ring, with alternating B and O atoms. The methyl groups are bonded to the B atoms and are in the plane of the ring. B–O = 1·39 ± 0·02 Å; B–C = 1·57 ± 0·03 Å; and the B–O–B angle is 112 ± 4°. The electron configurations of these substances are discussed. The available data on B compounds are reviewed and it is decided that the method recently suggested by Schomaker and Stevenson for calculating interatomic distances is the most successful method available at present for accounting for the interatomic distances observed in B compounds. AUTHORS.

1385. The starch molecule. G. V. CAESAR AND M. L. CUSHING. *J. Phys. Chem.*, **45,** *pp.* 776–790, *May*, 1941.—The literature bearing upon the structure, length, and spatial configuration of the amylose molecule, inclusive of the question of the "second" or associative dimension, is critically reviewed. Molecular models have been assembled of α-glucose, amylose and cellulose, employing the Fisher-Hirschfelder atomic models. From these constructions the cellulose molecule (β-1:

4-glucopyranose linkage) yields an essentially straight-chain or linear configuration in accordance with accepted tenets; the amylose molecule yields a helical-spring configuration which tends to rationalize the distinctive properties of the chemical and physical behaviour of starch.
H. H. Ho.

1386. Self-consistent field for methane and its applications. R. A. Buckingham, H. S. W. Massey and S. R. Tibbs. *Proc. Roy. Soc. A*, **178**, *pp.* 119–134, *June* 12, 1941.—An approx. self-consistent field for methane has been obtained by first averaging the proton distribution over all orientations so as to obtain a spherically symmetrical field due to all the nuclei. The 8-electron problem then presented was solved by the usual self-consistent field method without exchange. Rapid convergence to self-consistency was found by using as initial approximations the charge distributions given by Coulson for the 2-quantum orbitals of the tetrahedral system, averaged over all orientations. The self-consistent wave functions are used to calculate the charge distribution, energy, diamagnetic susceptibility and polarizability of the molecule and also the van der Waals forces between 2 molecules. The scattering of slow electrons is also investigated in detail and compared with observations of total collision areas and angular distributions for methane. The observed similarity of behaviour between argon and methane in scattering slow electrons is reproduced by the theory provided the same approximation of using the self-consistent field without exchange is employed for each. Comparison of observed and calculated values of the quantities investigated indicate that the methane field is little less satisfactory than the corresponding fields for atoms.
Authors.

1387. Molal volume relationships among aliphatic hydrocarbons at their b.p. G. Egloff and R. C. Kuder. *J. Phys. Chem.*, **45**, *pp.* 836–845, *May*, 1941.—By means of equations of the type $V = a(n + 4{\cdot}4)^c + k$ the molal volumes of 63 aliphatic hydrocarbons (arranged in 14 different homologous series) at their b.p. are correlated with the number of carbon atoms in the molecule. The standard deviation of the calculated from the observed values is 0·48 ml. per mole. By means of equations of the type $\log (V - k) = At + B'$ the b.p. molal volumes of 43 aliphatic hydrocarbons in 9 homologous series are correlated with the b.p., with a standard deviation of 0·79 ml. per mole. The effect of the structure of the hydrocarbon molecule on the molal volume at the b.p. is discussed, and comparisons are made with the effect at 20°C.
Authors.

***1388. Precision method for determination of molecular weights.** H. P. Cady and M. J. Rarick. *J. Amer. Chem. Soc.*, **63**, *pp.* 1357–1360, *May*, 1941.—A new device for the precise, accurate, and rapid determination of the apparent mol. wts. of gaseous substances at atm. pressure and 200°C. is described. Values are reproducible to 0·01 unit. The accuracy is within ± 0·01 unit.
Authors.

See also Abstracts 1609, 1629.

COLLOIDS.

1389. Particle size in the vat dyeing of cellulose. E. I. Valko. *J. Amer. Chem. Soc.*, **63**, *pp.* 1433–1437, *May*, 1941.—The particle size of commercial vat dyestuffs was investigated by photographic recording of the sedimentation during centrifugeing. The average particle radius was found to be about 10^{-5} cm. The particle size of cold-dyeing vat dyes in the leuco state and of indigosols in solution was investigated by means of diffusion measurements. The average aggregation number was found to be 3. Crystallization phenomena of vat dyes absorbed on the fibre were studied by means of X-ray diagrams and the dyes classified into 3 groups according to whether they remain amorphous, crystallize by after-treatment, or simply by oxidation.
Author.

1390. Particle size determination by sedimentation. K. Kammermeyer and J. L. Binder. *Industr. Engng Chem.* (*Analytical Edition*), **13**, *pp.* 335–338, *May* 15, 1941.—A discussion of the various factors involved in sedimentation methods such as evaluation of experimental data, operating variables, viscosity of suspending medium, and the smallest and largest particle sizes involved, is followed by the description of an improved apparatus for the purpose. This permits the use of a suspending medium of high viscosity, and with it particle sizes corresponding to about 500 μ in dia. have been measured. The oil of high viscosity reduces the time of fall of even the largest particles sufficiently to permit of accurate measurement.
H. H. Ho.

1391. Polymerization of tung oil. VII–X. M. Tatimori. *Bull. Chem. Soc. Japan*, **16,** *pp.* 75–91, *March, and pp.* 114-125, *April*, 1941.—

1392. Suspension of solids in mixed liquids. E. W. J. Mardles. *Trans. Faraday Soc.*, **37**, *pp.* 321–327, *June*, 1941.—The sediment volumes and some viscosities of suspensions of solids in binary mixtures of liquids and sediment volumes of suspensions of kaolin in 2 ternary systems were measured; the sediment-volume measurements were repeated with the addition of small amounts of soluble colloidal substances which were found to decrease considerably the volume of settled solid, especially if the added colloid was highly dispersed in the liquid medium. The data have been discussed in comparison with results obtained with colloidal substances in mixed liquids. The settling behaviour of the solids in the different liquids is found to be complex; the density and viscosity of the medium are not sufficient to explain the results and it is necessary to take into consideration the degree of flocculation of the solid particles. The shape of the particles also has an important bearing on the rate of fall. Authors.

1393. Measuring smokes and rating efficiencies of industrial air filters. A. C. Robertson, J. G. Mulder and F. G. VanSaun. *Industr. Engng Chem.* (*Analytical Edition*), **13**, *pp.* 331–334, *May* 15, 1941.—A technique is described whereby it is possible to classify air filters critically by continuous measurement of concentrations of smoke-like materials in filtered and unfiltered air. By determining density differences of impingement traces it is possible to calculate percentage efficiencies of air filters. The apparatus consists of an impingement recorder and a photo-electric densitometer. The recorder operates continuously by impingement of air from a self-metering orifice on moving paper. The unit is readily portable. Authors.

1394. Effects of electrolytes in hydrophobic systems. I–III. F. Hazel. *J. Phys. Chem.*, **45**, *pp.* 731–755, *May*, 1941.—Part I deals with electric mobility and stability, and the critical mobilities of several monovalent ions of different coagulating power are determined for colloidal manganese dioxide. These values are higher the lower the coagulating power of the ions. Reduction in the charge of particles by adsorption is considered to be the controlling factor in coagulation by ions of higher valencies. Recent theories connected with electric mobility and stability are discussed. Part II investigates sol concentration and electrolyte stability. A proportionate increase in stability upon dilution was observed with all electrolytes for manganese dioxide sol and arsenic trisulphide sol. Dilution of the sols lowered their critical mobilities towards the electrolytes (with the exception of that of potassium chloride for arsenic trisulphide). On the dilution of a sol, the proportionate increase in stability with strongly adsorbable polyvalent ions was ascribed to the decrease in adsorbability of the coagulating ions, and/or to the critical mobility at which coagulation occurs. Part III studies mixtures of electrolytes and ion antagonism. Flocculation studies have been made on manganese dioxide sols and arsenic trisulphide sols, each at 3 different sol strengths, with the electrolyte mixtures KCl-$BaCl_2$ and KCl-$CrCl_3$. No ion antagonism was observed with the latter but pronounced ion contagonism exists with the former electrolyte mixture. An electrophoretic study of the systems has been made and the mobilities of the particles at the coagulating concentrations of the electrolyte mixtures determined. It was found that, as the concentration of potassium chloride, in a coagulating mixture with $BaCl_2$ or with $CrCl_3$, was increased, the critical mobilities likewise increased. These results are fully discussed. H. H. Ho.

1395. Studies in electrokinetics. XXIV. The electroviscous effect. I. In systems of sodium gum arabic. D. R. Briggs. *J. Phys. Chem.*, **45**, *pp.* 866–876, *May*, 1941.—The Smoluchowski equation for the electroviscous effect is put into a form which makes possible its testing against experimental data obtained from measurements of the electro-kinetic potentials, specific conductivities and relative viscosities on colloid-containing solutions. H. H. Ho.

*1396. **Quantity-type rotor for the ultra-centrifuge.** A. V. Masket. *Rev. Sci. Instrum.*, **12**, *pp.* 277–279, *May*, 1941.—An improved design for fixed-angle quantity-type rotors is presented in which the holes are drilled at 10° to the axis of rotation and the Lusteroid tubes containing the centrifugate are individually sealed by means of tapered plugs. The advantages of this design are (*a*) increased capacity for a given rotor diameter, (*b*) prevention of tube collapse at all speeds and (*c*) more efficient concentration of materials in solution. Some charts illustrating differential sedimentation and concentration of proteins are given. Author.

See also Abstract 1455.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

1397. Conversion of energy in crystalline phosphors. F. Möglich and R. Rompe. *Phys. Z.*, **41**, *pp.* 236–242, *May*, 1940. *In German.*—Current theories of crystalline phosphors of the ZnS type postulate a filled and an empty electronic band, with a set of activator (impurity) levels near the top of the filled band and a set of trapping states near the bottom of the empty band. The authors review these theories and investigate the probabilities of the elementary transitions involved. The density of electrons in the upper band is calculated as a function of light intensity, and mechanisms are considered by which these electrons are brought into thermal equilibrium with the crystal lattice. Collisions between electrons are responsible for the division of energy among them. The relative importance of single and multiple collisions between electrons and lattice in transferring energy between them is considered for various temperature ranges. G. P. H.

1398. Wide-angle diagram produced by X-rays or electrons as a representative of the reciprocal lattice of the atomic lattice of various crystals.

H. Seemann. *Phys. Z.*, **41,** *Aug.* 15, 1940. *In German.*—The author represents the way in which waves interfere in a space lattice by manifold projective and inversion transformations in the plane of the photographic plate. A wide-angle diagram obtained with X-rays, or matter waves, is a reciprocal net which corresponds to a plane cross-section of the irradiated crystalline zones. Lines of higher order in a wide-angle diagram may be obtained by translations from those of the first order, and the deviations of the lines from straightness (they are very flat hyperbolae) can be handled as certain steps in the transformations used to discuss the interference. The wide-angle figures obtained experimentally can be transformed back so as to obtain the original lattice in 3 ways. The first is by obtaining the reciprocal lattice and using this to get the space lattice. The second translates the corners of the wide-angle net in the direction of the incident waves. The third method is new and requires 4 successive transformations. G. P. H.

1399. X-ray diffraction in random layer lattices. B. E. Warren. *Phys. Rev.*, **59,** *pp.* 693–698, *May* 1, 1941.—Random layer lattice structures are considered which consist of layers arranged parallel and equidistant, but random in translation parallel to the layer, and rotation about the normal. Equations are developed for the intensity distribution in a 2-dimensional powder reflection and for the integrated intensity. Equations are also also developed for the particle size in terms of the peak breadth and for the displacement of the peak. The powder pattern of a heat-treated carbon black is presented as an illustration of 2-dimensional lattice reflections. Author.

1400. Non-Laue maxima in diffraction of X-rays from rocksalt—Equatorial maxima. G. E. M. Jauncey and O. J. Baltzer. *Phys. Rev.*, **59,** *pp.* 699–705, *May* 1, 1941.—Cu$K\alpha$, Cu$K\beta$, or Mo$K\alpha$ X-rays with a weak background of continuous radiation were diffracted from an etched cleavage face of a thick rocksalt crystal. With the crystal face set to give the 200 reflection of Cu$K\alpha_1$ a total divergence of 1·6′ was found in the reflected beam, indicating very little warping in the layers near the crystal surface. With the crystal face turned by steps of 1° from a glancing angle of 45°07′ to 28°07′ the positions of the non-Laue max. associated with the 400 and 620 Bragg reflections were found. All photographs showed a shift of the max. intensity of the associated Bragg spot (or non-Laue spot) from the position of the corresponding Bragg spectrum line which is greater than zero. This result differs from that of Raman and Nilakantan, who report zero shift with rocksalt. The observed shift is always less than Zachariasen's theoretical value for a given Δ, the angle by which the crystal is set away from the position for a Bragg reflection. From the value of Δ at which the associated Bragg spots disappear the shortest effective wavelengths of the elastic waves concerned are found to be about 13 Å to 17 Å. These are between 2 and 3 times the min. wavelength in Debye's sp. ht. theory. Authors.

1401. Laue diagrams of Rochelle salt powder compressed into discs at high pressure. K. Deutsch. *Z. techn. Phys.*, **21,** 6, *p.* 134, 1940. *In German.*—Two photographs are given showing that after the compression at moderate pressures Laue spots are still visible, but when higher pressures are used the Laue spots degenerate into asterisms. J. J. W.

1402. X-ray crystal photography at low temperatures. K. Lonsdale and H. Smith. *J. Sci. Instrum.*, **18,** *pp.* 133–135, *July*, 1941.—Low-temperature X-ray photographs can be taken very simply, by enclosing the substance, solid or liquid, in a thin cellophane tube and allowing a narrow stream of liquid oxygen to pour constantly over it. Such photographs can be used for investigations of low-temperature crystal structure, coefficients of expansion, problems involving the heat motions of atoms and molecules, analysis or identification of unknown liquids or mixtures of liquids. Authors.

1403. Applications of X-ray methods in the examination of organic crystals. A. Hargreaves and W. H. Taylor. *J. Sci. Instrum.*, **18,** *pp.* 138–144, *July*, 1941.—The nature of the information which can be obtained from a rapid examination of a crystalline material, using routine X-ray methods, is illustrated by reference to investigations of calycanine and of a series of substituted diphenyls. This is followed by a discussion of the results of a more detailed analysis of *m*-tolidine dihydrochloride which was shown to be suitable for this further investigation in the course of the preliminary general survey of the substituted diphenyls. In favourable cases the use of the X-ray technique may result in great economy of time and effort, or it may give information unobtainable by other means, but if the best use is to be made of this research tool it is most important that the limitations of the method shall be fully understood. Authors.

1404. The derivation of lattice spacings from Debye-Scherrer photographs. H. Lipson and A. J. C. Wilson. *J. Sci. Instrum.*, **18,** *pp.* 144–148, *July*, 1941.—The usual film arrangements for Debye-Scherrer powder photographs are described and compared, and their adaptation to larger cameras is considered. Methods which eliminate systematic errors are given for the calculation of spacings. Particular attention is paid to cameras of 19 cm. dia. Methods of calibration are de-

scribed in detail, and an example is given of the measurement of a photograph of Al and the calculation of the lattice parameter from it.
AUTHORS.

1405. Systematic determination of crystal orientation. J. THEWLIS. *J. Sci. Instrum.*, **18,** *pp.* 148–150, *July*, 1941.—A description is given of a graphical method for the determination of crystal orientation which has been employed with success at the N.P.L. General formulae are also given for the determination of orientation by straightforward calculation. The graphical method and the general formulae are applicable to all crystal systems. AUTHOR.

1406. Some applications of X-ray technique to the study of preferred orientation of crystals in metals. T. L. RICHARDS. *J. Sci. Instrum.*, **18,** *pp.* 150–152, *July*, 1941.—Selective orientation of crystals in materials is shown to be a common feature in many industrial problems. The most suitable methods for its examination are enumerated and references are given to examples of the application of these methods. The preferred orientation of crystals is best represented by pole figures, which may also provide an indication of the mechanism involved in certain types of deformation and during subsequent recrystallization. The manner in which preferred orientation studies should be applied to problems of deformation and annealing is suggested, and 2 examples are given.
AUTHOR.

1407. X-ray diffraction and the deformation of metals. W. A. WOOD. *J. Sci. Instrum.*, **18,** *pp.* 153–154, *July*, 1941.—A brief survey is made of the principal changes in structure of a metal during deformation which are brought out by application of X-ray diffraction methods. Reference is made to the changes associated with the yield point, to the principle of the lower limiting crystallite size, and the sequence into which these structural changes fall. A brief sketch is also given of the behaviour of the atomic lattice of a metal under tensile stress, and of the characteristics of the lattice stress/strain diagram. AUTHOR.

1408. Development of texture in copper by cold-rolling. H. C. VACHER. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 385–404, *May*, 1941.—The structural changes occurring in one polycrystalline and in 5 monocrystalline specimens as they were cold-rolled from 1 to 0·005 in. thickness were studied largely by X-ray diffraction methods. The macrostructure of cross-sections of monocrystalline specimens, after increasing reductions, showed that in some specimens 2 or 3 distinct layers were developed whose boundaries were approx. parallel to the rolling plane. Changes in orientation showed that the lattices of adjacent layers of a monocrystalline specimen rotated in opposite directions around axes nearly parallel to the transverse direction to positions approx. 2 of 5 intermediate orientations. Orientations present after 99·5% reduction indicated that the 5 intermediate orientations were in the process of being changed to twin $110–1\bar{1}2$ or twin $112–\bar{1}\bar{1}1$ orientations. AUTHOR.

1409. Crystal structures of tetragonal monoxides of Pb, Sn, Pd and Pt. W. J. MOORE, JR. AND L. PAULING. *J. Amer. Chem. Soc.*, **63,** *pp.* 1392–1394, *May*, 1941.—Powder-photographic X-ray data are used to show that the tetragonal crystal PbO has the structure assigned it by Dickinson and Friauf, and not that suggested by Levi and Natta. SnO has a similar structure. The tetragonal crystals PdO and PtO have a different structure (suggested by Huggins), in which the metal atom forms a coplanar rectangular co-ordination group.
AUTHORS.

1410. Nucleus formation in aqueous solution. U. DEHLINGER AND E. WERTZ. *Ann. Phys., Lpz.*, **39,** 3, *pp.* 226–240, *March*, 1941. *In German.*—Spontaneous nucleus formation in supersaturated aqueous solutions is investigated by determining the times of start in an alum solution at 0°, 20° and 40°C. Below a limit of concentration slightly dependent upon temperature and near 4 mol.% $KAl(SO_4)_2$ no spontaneous nucleus formation set in after a year. A sharp boundary thus exists between metastable and stable supersaturated solutions. An attempt to apply the theory of Volmer and others of nucleus formation from the vapour state to this boundary curve shows that the sharpness of the experimental boundary, as also its temperature curve, cannot be brought into agreement with the theory. On the other hand, nucleus formation by negative diffusion affords an explanation. Each dissolved ion is to be assumed as tending to surround itself with 6 water molecules; thus only a part of the ions is still separated by a layer of water molecules above 4 mol.%. The Coulomb forces then occurring between the ions cause at lower temperatures a max. in the concentration curve of the thermodynamic potential near 4 mol.% and thus a negative diffusion coefficient above this concentration. H. G. S.

1411. Effect of crystal orientation on Raman effect in naphthalene and benzophenone. T. M. K. NEDUNGADI. *Proc. Indian Acad. Sci. A*, **13,** *pp.* 161–176, *March*, 1941.—The paper reports a study of the Raman spectra of single crystals of naphthalene and benzophenone, and a polarization study of benzophenone in the molten state; 4 lattice and 28 internal oscillations are observed in naphthalene; 22 lines, including 3 lattice lines, are recorded in benzophenone crystal and 27 lines in its melt, 151 being polarized. The effect of orientation of the crystals on their Raman spectra is studied. Remarkable changes in the intensities of some of the Raman lines are observed, depending upon the orientation of the crystal with respect to the directions of incidence and observation and the states of polarization of the incident light. From the observed changes in intensities and the known molecular orientations in the crystal it is deduced that the incident light vector vibrating in the plane of the aromatic ring excites some oscillations of the molecules much more strongly than the light vector perpendicular to that plane. AUTHOR.

See also Abstract 1462.

DENSITY.

1412. Specific gravities and electrical conductances of some $CaSO_4$ solutions and mixtures of NaCl and $CaSO_4$. R. E. HAMM WITH T. G. THOMPSON. *J. Amer. Chem. Soc.*, **63**, *pp.* 1418–1422, *May*, 1941.—The conductances of mixtures of NaCl and $CaSO_4$ having a constant ionic ratio, and the conductances and sp. gr. of solutions of $CaSO_4$, are reported at the temperatures 0°, 5°, 10°, 15°, 20° and 25°C. The $CaSO_4$ solutions and the mixtures were found to follow the Root equation and the constants determined by the method of least squares are given. NaCl solutions of 3 different conc. with varying quantities of $CaSO_4$ were prepared and the sp. conductances were determined at 25°. AUTHORS.

ELASTICITY AND PLASTICITY.

1413. One-dimensional examples in the mechanics of plastic deformation. T. PÖSCHL. *Z. techn. Phys.*, **21**, 5, *pp.* 110–115, 1940. *In German.*—The author gives a simple representation of the phenomena of plastic flow by introducing into the equation of motion a negative term proportional to the speed of deformation. The const. of proportionality is a kind of internal friction. J. J. W.

1414. Elastic and thermo-elastic properties of rubber-like materials. E. GUTH AND H. M. JAMES. *Industr. Engng Chem.*, **33**, *pp.* 624–629, *May*, 1941.—A development of the statistical theory of the elasticity of rubber and similar high-molecular compounds is applied to rubber-type materials similar to vulcanized rubber and gives the relation of stress to temperature and to elongation for both extension and compression. No arbitrary constants, except a scale factor, enter into the theoretical formula. This statistical theory applies for either hindered or free rotation of the C–C bonds in the rubber molecule. The structure is assumed to be that of long-chain molecules interlinked by cross bonds (primary or secondary valences) to a 3-dimensional network. The experimental evidence concerning the variation of the stress with temperature and deformation for both extension and compression is in agreement with the theory. AUTHORS.

1415. The analogy between the mechanism of deformation of cellulose and that of rubber. P. H. HERMANS. *J. Phys. Chem.*, **45**, *pp.* 827–836, *May*, 1941.—This paper gives a résumé of the corresponding phenomena observed upon the stretching of isotropic cellulose filaments and isotropic rubber, and includes the comparison of X-ray patterns, optical behaviour in polarized light and a discussion of the reason why the stretching process is entirely or partially reversible with rubber and not with cellulose. The final section deals with the general concept of the formation and structure of artificial textile fibres of cellulose (rayon). The following items seem significant for the determination of the essential properties and the quality of regenerated filaments: (1) the distribution of chain length in the spinning solution; (2) the average degree of longitudinal orientation of the molecules and of the crystallites; (3) the average proportion of crystalline and non-crystalline matter in the fibre; (4) the distribution of the conditions mentioned under (2) and (3) over the cross section of the fibre. H. H. HO.

1416. Plasticizers for cellulose organic ester plastics. W. E. GLOOR AND C. B. GILBERT. *Industr. Engng Chem.*, **33**, *pp.* 597–601, *May*, 1941. —The chief factors determining properties of cellulose organic ester thermoplastics are the amount of non-cellulosic material, whether chemically bonded to the chains or colloidally held, and the kind of plasticizer held by such colloidal bonds. Both spatial structure and substitution of the plasticizer are important. Essential features of the structure of tough and brittle plastics are outlined. AUTHORS.

1417. Relations of flow and physical properties with formulation in cellulose acetate plastics. W. E. GLOOR. *J. Appl. Phys.*, **12**, *pp.* 420–425, *May*, 1941.—Single plasticizers exert specific effects on flow and physical properties of the plastics. Mixtures of such plasticizers give plastics with properties which may be predicted by a simple proportion based on the amount of each plasticizer used. Results of Rockwell hardness, elastic modulus, impact strength and water absorption tests, of moulded plastics are discussed. No general relation is found between flow properties of the plastics at moulding heats and physical properties at room temperatures. AUTHOR.

1418. Internal resistance of solid bodies. S. HIGUCHI. *J. Franklin Inst.*, **231**, *pp.* 421–445, *May*, 1941.—Using new types of cantilever test-pieces made of 7 different metals and taking necessary precautions in carrying out the present experiment, the natural oscillations of these metals are carefully examined. Based on the results of these experiments, the law of the internal resistance of solids is studied. The main conclusions arrived at are as follows: in the state of small stress, the law of viscous resistance may be recognized as being true, as was already expected by the present writer from his previous investigations. AUTHOR.

1419. Reflection and refraction of attenuated waves in semi-infinite elastic solid media. I. D. SETH. *Proc. Indian Acad. Sci. A*, **13**, *pp.* 151–160, *March*, 1941.—In earthquakes it is known that waves of one type starting from the origin inside the earth produce waves of other types after impact at the free surface of the earth. The author discusses the reflection and refraction of waves which have their amplitudes increasing with depth like the initial diverging earthquake waves which, after reflection, produce the apparent surface waves in which the displacement decreases with depth. In one case it is found that at a free surface a plane wave of SV type, travelling parallel to the surface, is capable of generating surface waves after internal reflection which, in a certain state of attenuation, are identical with the Rayleigh waves. AUTHOR.

1420. Entropy diagram of materials. W. BÜTTNER. *Arch. Wärmew.*, **21**, *pp.* 59–62, *March*, 1940. *In German.*—The author proposes a determination of the factor of safety by an investigation of potential energy and entropy of a stressed material. The decrease in the temperature of a bar under tensile stress was supposed by Thomson to be a linear function of the stress. Recent investigations show that this dependence is polytropic and that hysteresis takes place when a certain stress is exceeded. This leads to the proposal of making the factor of safety equal to the ratio of the differences between the temperature at the start and that at the yield point and between the temperature at the start and that at the point when hysteresis sets in. R. N.

1421. Further investigations of solid *n*-paraffins. (Repulsion potential and compressibility.) A. MÜLLER. *Proc. Roy. Soc. A*, **178**, *pp.* 227–241, *June* 12, 1941.—[See Abstr. 1940 (1936)]. Experiments are made on the compressibilities of solid *n*-paraffins. The lattice deformations due to pressure are measured with the aid of X-rays, the pressures ranging between 700 and 1 500 atm. It is found that the linear compressibilities in a plane normal to the chain axes are of the order of 3 to 12 × 10^{-12} cm.^{2}/dyne. The compressibility in the direction of the chain is less than 3 × 10^{-13} cm.^{2}/dyne. Numerical estimates show that the repulsive forces between paraffin chains have their origin essentially in the H shells that surround the C chain. The forces are of the same order as those existing between He atoms. AUTHOR.

1422. Elasticity of solid solutions, in particular those of Au and Cd. C. BENEDICKS. *Ark. Mat. Astr. Fys.*, **27A**, **18**, [11 pp.], 1940.—Solid solutions, especially when super-saturated, have a lower Young's modulus than the pure metals of which they are composed, although they are considerably harder. It might be due to an increase in the atomic distance, but this would not be great enough to account for the observed effect. If, however, it is supposed that the atoms are not arranged in straight lines, as in pure metallic lattices, but along undulatory lines, as in the strongly deformed lattice of a super-saturated solid solution, the increase in atomic distance can explain the effect. Investigation of the Au-Cd system, and particularly of the alloy $Au_{1\cdot05}Cd_{0\cdot95}$ shows that the latter has a very high elastic limit, and an extremely low initial value of the modulus. It has also been shown that it possesses a strongly deformed undulatory lattice of the CsCl type, in agreement with the above conception. A. J. M.

1423. Relationship between stress and strain in the tensile-impact test. A. F. C. BROWN AND N. D. G. VINCENT. *Proc. Instn Mech. Engrs, Lond.*, **145**, *pp.* 126–134, *June*, 1941.—Apparatus has been devised for the measurement of the relationship between stress and strain on metallic specimens broken in tensile impact. The stress was measured piezo-electrically and the strain photo-electrically. Five ferrous materials have been examined at rates of extensional strain ranging up to 800 in./in./sec. with the following results: With wrought iron there was an increase in tensile strength and considerable increase in yield point as the rate of strain was raised. With medium-carbon steel there was some increase in the yield point. With low-carbon Mn steel, Ni-Cr steel and Vibrac steel there was little difference between the impact and static stress/strain diagrams. The energy absorbed in fracture of the specimens in the impact tests was only slightly greater than that absorbed in the static tests. AUTHORS.

1424. Evaluating the wearing quality of currency paper. F. T. CARSON AND V. WORTHINGTON. *Bur. Stand. J. Res., Wash.*, **26**, *pp.* 467–480, *June*, 1941.—This report describes means which have been developed to determine the relative serviceability of currency-type papers. A reproducible crumpling and smoothing cycle has been developed with which to imitate the appearance and characteristics of worn paper currency. The changes in significant physical properties of this worn paper are then measured. An automatic, motor-driven crumpling apparatus is used, which alternately crumples and straightens out a specimen at a rate of about 7 times per min. The change in air permeability as the crumpling procedure progresses appears to be the most useful single measure thus far found of the decreasing serviceability of the paper. An air permeameter, specially designed for use in conjunction with the crumpling apparatus, is briefly described. AUTHORS.

HYDRODYNAMICS AND AERODYNAMICS.

1425. Propagation of cylindrical and spherical waves in frictionless gases and liquids. K. BECHERT. *Ann. Phys., Lpz.*, **39**, 3, *pp.* 169–202, *March*, 1941. *In German.*—In this mathematical work solutions are given for the problem of the propagation of cylindrical and spherical waves in frictionless gases and liquids in polytropic change of state, neglecting heat conduction and gravity and regarding pressure as dependent solely on density. The subject is dealt with as follows: Part I: Introduction. Results. Part II: Cylindrical and spherical waves for which ρ depends only on u. §1. Reduction of the problem to the integration of an ordinary differential equation of the 1st order (eq. 16). §2. General properties of the motion. The singular integrals of eq. 16. §3. Integration of eq. 16. The case $n = -1$ (liquids). §4. A special cylindrical wave in liquids. Part III. More general cylindrical and spherical waves. §5. A more general expression for cylindrical and spherical waves; reduction to the integration of an ordinary differential equation of the 1st order (eq. 51). §6. General properties of the motion. The case $\alpha = -1$. The singular integrals of eq. 51. §7. Discussion of eq. 51. Part IV. §8. The problem of the general solution for cylindrical and spherical waves. Appendix: Derivation of the general integral from the complete integral (eq. 52). [See Abstr. 2004 (1940)]. H. G. S.

1426. Transition from laminar to turbulent flow in the boundary layer. A. FAGE AND J. H. PRESTON. *Proc. Roy. Soc. A*, **178**, *pp.* 201–227, *June* 12, 1941.—Information on transition on streamline bodies of revolution in a water stream is obtained from visual and photographic observation of the movements of small particles and filament bands. The cases considered are transition caused by isotropic turbulence in the free stream, by a falling velocity in a stream substantially free from turbulence, and by flow disturbances from surface wires. A non-dimensional number, specified in terms of the intensity and scale of turbulence, the boundary-layer thickness, and the mean velocity just outside the layer, is found to be representative of the conditions of flow in the boundary layer of a body in a turbulent stream: and values of this number at transition obtained from observations made for a body of revolution have the same order of magnitude as those calculated for a flat plate from measurements taken by Hall and Hislop. Transition in a region of falling velocity in a steady stream arises from a separation of the laminar boundary layer from the surface; and after separation the flow in the layer becomes turbulent and then rejoins the surface. The observed position of transition is near the position of separation given by a solution of the momentum equation for laminar flow and for the observed distribution of velocity just outside the layer. Flow disturbances from a surface wire placed in a laminar boundary layer cause fully developed turbulent flow to be established at the wire when $u_2 d/\nu > 400$, where d is the wire diameter, u_2 is the velocity in the laminar layer at a distance d from the surface, and ν is the cinematic viscosity. The measured max. value of the downstream component of turbulent velocity in the stream behind a grid is about 3·3 times the r.m.s. value. AUTHORS.

1427. Friction and heat transmission coefficients of rough pipes. W. F. COPE. *Proc. Instn Mech. Engrs, Lond.*, **145**, *pp.* 99–105, *June*, 1941.—Three pipes were tested, their internal surfaces being artificially roughened by a special knurling process which produced a series of pyramids geometrically similar in form but varying in absolute size from pipe to pipe. The roughness ratios (radius of pipe)/(height of pyramid), were approx. 8/1, 15/1 and 45/1. The apparatus used was basically the same as that used in previous tests [*Proc. Instn Mech. Engrs, Lond.*, **137**, *p.* 165, 1937]; the working fluid was water, and the Reynolds number ranged from 2 000 to 60 000. The results indicate that when fully turbulent conditions are established the roughness has very little effect on the heat transmission coefficient, but that, in the transition region between laminar and fully turbulent flow, the roughness may increase that coefficient to considerably more than its value for a smooth pipe; and that the heat transmission graphs for the 3 pipes are in better agreement if shearing force velocity is used instead of mean velocity in forming the non-dimensional parameters used for plotting purposes. The broad conclusions from the practising engineer's standpoint are (1) for a given pressure drop across a heat transmission apparatus more heat will be transmitted if the pipes be smooth than if they be rough; (2) the velocity of the working fluid will, of course, be greater with smooth pipes; and (3) the smooth pipe is more efficient if the comparison is made on a basis of heat transmission for equal power. AUTHOR.

1428. Investigation of resistance and distribution of velocity in regularly and artificially roughened

pipes for turbulent flow. H. Möbius. *Phys. Z.*, **41,** *pp.* 202–225, *April* 15, 1940. *In German.*—Artificial roughness elements are introduced into pipes by arranging systematically a set of rings along the walls. The ring height (k) projecting into the pipe is varied regularly, as well as the average pipe radius (r) and the spacing between rings (L_2). It is shown that Reynolds's similarity law holds for roughened pipes of this kind. The resistance of 10 pipes of different roughness is measured in a region where the Reynolds number, referred to the dia. of the pipes, changes between 7×10^3 and 400×10^3. The relative roughness varies between $k/r = 0{\cdot}03$ and $0{\cdot}22$ and the relative ring separation between $L_2/k = 8{\cdot}2$ and $60{\cdot}8$. The roughened pipes show an approx. quadratic dependence of resistance on the Reynolds number in almost the whole range of Reynolds number. In addition, the radial velocity distribution is determined in 3 roughened pipes and 1 smooth one. These data on resistance and velocity distribution are thrown into a form which agrees well with the theory of Prandtl. In many cases the author's data also agree well with those of Nikuradse. A discussion is given which indicates that the resistance should have a max. value as the ratio L_2/k is increased from 0 to ∞. G. P. H.

1429. Model tests on Liawenee canal roughness coefficients. G. T. Colebatch. *J. Instn Engrs, Aust.*, **13,** *pp.* 27–32, *Feb.*, 1941.—A description is given of model tests carried out to determine the equivalent roughness coefficient in open channels in which the roughness differs on sides and bed. A formula is developed and presented as a nomograph, the accuracy of which is believed to be sufficient for practical purposes. Author.

See Abstracts 1502, 1505.

KINETIC THEORY OF MATTER.

1430. Calculation of energy exchange between lattice oscillators. J. H. Van Vleck. *Phys. Rev.*, **59,** *pp.* 730–736, *May* 1, 1941.—The paper is concerned with the flow of energy between oscillators at the same point of space, rather than that associated with spatial temperature gradients. The mean free paths for the two problems are shown to be unrelated, particularly at low temperatures, inasmuch as spatial thermal resistivity can be created by boundary or mosaic reflections, free from energy exchange, but does not arise from energy-transferring collisions between oscillators unless they are of the abnormal type in which momentum is imparted to the grating framework. The rate of flow of energy between a band of l.f. oscillators and the main body of lattice vibrations when the two are at slightly different temperatures proves to be proportional to T^4 at low temperatures. The corresponding collision frequency between oscillators is about 10^5 sec.$^{-1}$ even at He temperatures and thus is of such a magnitude that equilibrium between the vibrations can be regarded as secured instantaneously from the standpoint of macroscopic acoustical experiments, but not at all as far as paramagnetic dispersion is concerned. Author.

LENGTH, AREA AND VOLUME.

1431. General measurements. W. Keil. *Phys. in regelmäss. Ber.*, **8,** 1, *pp.* 1–16, 1940. *In German.*—This report covers the literature published since the previous report [Abstr. 4009 (1936)] till the end of 1938. Special progress has been made in the application of length measurement for the total range of mechanical production, in measurement of time, in static gravity measurements and in the development of the ultra-centrifuge. Items not dealt with in the previous report concern measurements on toothed gearing, space-mass measurements and calculating and evaluating appliances. A Bibliography of 232 publications is given. R. N.

***1432. Modifications of apparatus for volumetric gas analysis.** M. Shepherd. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 351–356, *April*, 1941.—[See *Bur. Stand. J. Res., Wash.*, **6,** *pp.* 121–167, *Jan.*, 1931].

MASS.

***1433. Apparatus for absorption or gravimetric determination of constituents of a gas mixture.** M. Shepherd and H. W. Bailey. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 347–349, *April*, 1941.—The apparatus eliminates many of the undesirable features of certain types of absorption trains which are intended to remove constituents from gas mixtures or to determine them gravimetrically. It is adaptable to many uses, since auxiliary units, such as combustion apparatus, may be connected by means of interchangeable joints. Authors.

See also Abstract 1431.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

1434. A new treatment of the theory of dimensions. G. B. Brown. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 418–432, *July*, 1941.—A new treatment of the theory of dimensions is proposed, based on consideration of the manner in which numbers are introduced as symbols for certain aspects of nature. It is shown that there are only 2 direct ways of doing this, the measurement of length and the measurement of time. These are not independent, as the first involves the second; they are related by a universal constant which is there called the *constant of interaction*, in preference to the "velocity of light". This leads to a very simple formulation of the dimensions of physical quantities in terms of symbols representing length and time measurements only, and to a new use for dimensional equations in checking theoretical predictions of the relations between different physical quantities such as mass and energy. AUTHOR.

1435. The dimensions of physical quantities. W. E. DUNCANSON. *Proc. Phys. Soc., Lond.*, **53**, *pp.* 432–448, *July*, 1941.—As a basis for the discussion of the dimensions of physical quantities, the 3 usual quantities (length, time and mass) are taken as indefinables and the mechanical quantities are defined in terms of these. The dimensions follow directly from the definition of a quantity and indicate the type of measurements that have to be made to determine the magnitude of those quantities. It is shown that a further indefinable is necessary for defining electrical and magnetic quantities, and reasons are given for choosing electric charge for this purpose. It is pointed out that when the dielectric constant and the permeability are equated to unity for a vacuum it amounts to using these two quantities as indefinables, which, although in some cases convenient from practical considerations, is not necessary. For defining thermodynamical quantities only the 3 indefinables, mass, length and time, are used. The introduction of Boltzmann's constant as a numerical scale factor is not necessary but gives a more convenient unit of temperature. The significance of the introduction of such scale factors is also discussed from a more general point of view. Finally, it is shown that 3 indefinables are not necessary for measuring the magnitude of mechanical, and hence thermodynamical, quantities and these can be quite adequately defined in terms of length and time only, while electrical and magnetic quantities are measured in terms of length, time and charge. AUTHOR.

1436. Expansions containing Laguerre polynomials and their expressions in terms of Whittaker's confluent hypergeometric functions. D. P. BANERJEE. *Phil. Mag.*, **32**, *pp.* 84–85, *July*, 1941.

1437. The first variation of the Dirichlet-Douglas integral and the method of gradients. R. COURANT. *Proc. Nat. Acad. Sci., Wash.*, **27**, *pp.* 242–248, *May*, 1941.

1438. Generalization of theorems of Schönhardt and Mehmke on polytopes. R. BRAUER AND H. S. M. COXETER. *Trans. Roy. Soc. Can., Sect. III*, **34**, *pp.* 29–34, *May*, 1940.

1439. Note on Mohr's circle. H. J. B. PUTMAN. *Trans. Roy. Soc. Can., Sect. III*, **34**, *pp.* 43–46, *May*, 1940.

MECHANICS, CLASSICAL.

1440. Facts about the rifle. D. WEIR. *Engineer, Lond.*, **171**, *pp.* 314–316, *May* 16, *and pp.* 330–333, *May* 23, 1941.—Details of the dia. of bore, weight of bullet, muzzle velocity, etc., for various service rifles, are given. The rifling of the barrel and the jump, or lateral vibration, of the barrel during discharge are described. The decrease of air resistance when the speed of the bullet drops below the velocity of sound is discussed. The method of aiming by the use of a foresight and backsight, as opposed to the theoretical method of sighting along the axis of the barrel, is described. The various factors which deflect the bullet when wind is present are discussed in detail. An account of the effects of spin, of the phenomenon of "yaw" and of the recoil of the rifle, concludes the paper. Numerous explanatory graphs and diagrams are included. G. C. McV.

1441. Classical limit of heavy homogeneous spherical masses. V. V. NARLIKAR. *Proc. Indian Acad. Sci. A*, **13**, *pp.* 240–244, *March*, 1941.—It is shown that the classical theory effectively brings out the distinction between the effective and proper masses of a homogeneous sphere. The formula derived to clarify this point leads to an upper limit for the effective mass of a sphere which is analogous to Schwarzschild's. The bearing of the limit on the flatness of nebulae is pointed out. AUTHOR.

MECHANICS, QUANTUM.

1442. The Larmor theorem in wave mechanics. R. KNITTEL. *Ann. Phys., Lpz.*, **39**, 1, *pp.* 51–54, *Jan.*, 1941. *In German.*—The author demonstrates how this theorem can be derived in complete analogy with classical mechanics. Schrödinger's time-conditioned equation with vector potential is transformed to a system of rotating co-ordinates. By choosing the angular velocity equal to the Larmor frequency the Schrödinger equation for potential forces results. The effect of the transformation on the amplitude equation is investigated, and a derivation is given of the Schrödinger equation for magnetic fields. H. G. S.

1443. Bose-Einstein statistics and degeneracy. D. S. KOTHARI AND B. N. SINGH. *Proc. Roy. Soc. A*, **178**, *pp.* 135–152, *June* 12, 1941.—The thermodynamic properties of degenerate and non-degenerate Bose-Einstein gas in the completely non-relativistic and the completely relativistic cases are derived. The relativistic degenerate case of Bose-Einstein statistics corresponds to black-body radiation. The properties and the possibility of the existence of non-degenerate radiation are discussed. AUTHORS.

1444. Interaction between elementary particles. W. Scherrer. *Helv. Phys. Acta*, **14**, 1, *pp.* 81–84, *and* **14**, 2, *p.* 130, 1941. *In German.*—The author bases his theory of the interaction between elementary particles on 3 fundamental requirements. Firstly, each particle obeys a separate wave equation; secondly, the vector potential acting on each individual particle is, except for a universal factor, equal to the material wave current of all the remaining particles; and thirdly, the differential equations used are the relativistic wave equations of Schrödinger. The case is worked out for 2 particles. It is shown to lead to a pair of equations. Several deductions from these equations are mentioned and in particular their connection with pair production. In the additional note (second ref.) the equations are expressed in a different form and further discussed. G. O. B.

1445. A new treatment of some eigenvalue problems. L. Infeld. *Phys. Rev.*, **59**, *pp.* 737–747, *May* 1, 1941.—By this treatment the solutions can be found immediately once the equations have been factorized by means of linear operators. These operators acting on a normalized eigenfunction change it into a new normalized eigenfunction, and all solutions can be found once the basic eigenfunction is known. This basic eigenfunction is a solution of a simple differential equation of the first order. The paper contains some applications of the method, including the Kepler problem treated according to Dirac's theory. Author.

1446. The phase transition in liquid He. L. I. Schiff. *Phys. Rev.*, **59**, *pp.* 758–763, *May* 1, 1941.—The paper investigates the influence of binary collisions on London's ideal Einstein-Bose gas model of liquid He. It is shown that the condensation temperature and the continuity of the sp. ht. at this temperature are not affected. These results are independent of the force law assumed to hold between a pair of atoms. Explicit calculations for a rigid sphere interaction of small radius show that the sp. ht. is lowered near the condensation temperature. Possibly the phase transition observed in liquid He is characteristic of a condensed system and cannot be obtained from a gas approximation method. Author.

1447. Theory of degenerate non-ideal gases. L. I. Schiff. *Phys. Rev.*, **59**, *pp.* 751–757, *May* 1, 1941.—The partition function for a non-ideal quantum gas is calculated by considering the degeneracy exactly and the inter-particle forces only so far as binary collisions are concerned. In the absence of forces this reduces to the ideal Einstein-Bose or Fermi-Dirac gas, as the case may be, rather than to the ideal classical gas. If the wave functions describing the 2-particle collision are known, the partition function can be reduced to a set of quadratures. Possible applications are discussed. Author.

PRESSURE.

***1448. Manometric gas analysis apparatus.** M. Shepherd and E. O. Sperling. *Bur. Stand. J. Res. Wash.*, **26**, *pp.* 341–346, *April*, 1941.—The apparatus is designed for the analysis of gas mixtures under the following conditions: (1) When the volume of the sample is small—about 5 to 0·5 ml.—and a reasonably accurate analysis is desired. (2) When the volume of the sample is of the order of magnitude of 0·2 to 0·1 ml. and an approx. microanalysis is desired. (3) When the gases to be analysed are dissolved in some liquid from which they must be liberated prior to analysis, as in the analysis of blood gases. The apparatus is adapted for use with the procedures of van Slyke. The present design eliminates the two principal errors inherent in the van Slyke apparatus, as well as the mechanical shaking. By extending the apparatus here described, analysis by combustion may be performed and greater operating convenience achieved. Authors.

***1449. Recording sensitive differential manometer.** W. Hurst. *Rev. Sci. Instrum.*, **12**, *pp.* 265–268, *May*, 1941.—A sensitive differential manometer used in the recording of small differential pressures is described. This instrument responds to pressure differences as small as 0·00003 cm. of Hg and as rapid as 80 c./s. The moving element is a rectangular glass mirror 0·010 in. thick and approx. 0·060 in. × 0·080 in., supported on a glass shaft 0·007 in. in dia. Motion is supplied by a thin rubber diaphragm approx. 0·003 in. thick. Included in recordings made with the aid of this instrument are wave forms originating in the human neck and finger, also pressure changes in a glass cell enclosing a tracheal breathing insect. Author.

RELATIVITY AND ETHER.

1450. Existence of a metric for path-spaces admitting the Lorentz group. M. Shabbar. *Proc. Indian Acad. Sci. A*, **13**, *pp.* 203–210, *March*, 1941.

1451. Total mass of a particle in general relativity. C. Lanczos. *Phys. Rev.*, **59**, *pp.* 708–716, *May* 1, 1941.—Without specifying otherwise the stress/energy distribution inside a material particle, the assumption is made that the scalar quantity *T*, known in electromagnetism as the scalar of Laue, shall vanish, in harmony with the Maxwellian stress tensor. It is shown that under this condition a theoretical explanation can be given of the empirical fact that the mass of any particle is necessarily positive. All metrical contributions to the total mass are necessarily positive second-order quantities, the only exception being an eventual spin, which has a decreasing instead of increasing effect on the mass. The strict proportionality of gravitational and inertial mass can still be established, at least for the spherically symmetric case. The factor of proportionality, however, is numerically different from the value ordinarily assumed. AUTHOR.

SOLUTION.

1452. Precipitation in the solid state. G. D. PRESTON. *J. Sci. Instrum.*, **18,** *pp.* 154–157, *July,* 1941.—The course of events in the separation of a second phase from a supersaturated solid solution is outlined. The systems Al-Cu and Al-Ag are considered; in both cases the sequence of events is: formation of plates—intermediate phase—final phase. In the Al-Ag alloys the plates form on (111) planes, in the Al-Cu alloys on (100) planes. AUTHOR.

1453. Solubility studies. VI. Solubility of nitrobenzene in deuterium water and in ordinary water. H. E. VERMILLION, B. WERBEL, J. H. SAYLOR AND P. M. GROSS. *J. Amer. Chem. Soc.*, **63,** *pp.* 1346–1347, *May,* 1941.

See Abstract 1622.

SURFACE PROPERTIES.

1454. Ethylene and acetylene adsorption in hydrogenation catalysis. E. F. G. HERINGTON. *Trans. Faraday Soc.*, **37,** *pp.* 361–366, *July,* 1941. —The spatial conditions for the chemisorption of acetylene and ethylene on the crystal facets of Ni and CO are compared and it is shown that whilst C_2H_4 should be held on the short spacing 2·47 Å, C_2H_2 will be held on the long 3·50 Å. Support for these views is found in the different behaviour of these gases in the Fischer-Tropsch synthesis. AUTHOR.

1455. Sorption of clay minerals and organic soil colloids and determination of contribution of these colloids to soil sorption. P. SCHACHTSCHABEL. *Kolloid-Beih.*, **51,** *pp.* 199–276, *March* 12, 1940. *In German.*—The author reports investigations concerning the basis exchange of clay minerals, especially the naturally formed kaolins, montmorillonites and micas, in comparison with synthetic permutites. The experiments show that results of tests made on permutite are not transferable to clay minerals. Further investigations showed in which cases only extramicellar and in which both extra-and intramicellar exchange took place. This depends on the diameter of the hydralized ions as compared with the interstices of the layers of the minerals and affects the time required to reach equilibrium. The influence of the *p*H value on sorption was found to be much larger with micas than with montmorillonite or kaolin. Of the total sorption of anorganic colloids for 8 different soils mica participated with an average of about 30% and montmorillonite with about 70%. The sorption capacity of these substances was calculated. In a similar manner exchange tests were made with huminic acid and the sorption capacity of organic soil colloids was investigated. The anorganic and organic nutrients are unevenly distributed in the soil. Ca ions are mainly adsorbed by humus, K and NH_4 ions mainly by mica, while montmorillonite adsorbs either of them. Anorganic and organic soil colloids are equally important for plant nutrition. A Bibliography of 125 publications is given. R. N.

1456. Equilibria in phenol/water systems. G. ANTONOFF, M. HECHT AND M. CHANIN. *J. Phys. Chem.*, **45,** *pp.* 791–793, *May,* 1941.—Published data about this system are highly contradictory, and it is now shown that the calculated interfacial tension is reversible at will and depends upon the temperature—high temperatures tending to give initial positive values and lower temperatures promoting initial negative values. Some permanent changes such as colour may occur, but they are much slower and do not enter into consideration. These variations in the calculated interfacial tension cannot be regarded as surface phenomena only, because they are accompanied by substantial changes in density. These changes, therefore, must be due to some molecular rearrangements which occur with measurable velocity every time the system undergoes a change in temperature. It follows that the previous history of the solid phenol, the temperature of the solution, and the length of time that the solution is kept in the thermostat, are factors which affect the density, refractive index and viscosity. H. H. Ho.

1457. Comparative study of surfaces of solutions with the film balance and surface tension equipment. J. W. MCBAIN AND E. R. SHARP. *J. Amer. Chem. Soc.*, **63,** *pp.* 1422–1425, *May,* 1941.—It is shown for the surface of solutions of hydrocinnamic acid that the complicated phenomena discovered with the film balance are paralleled by changes in surface tension observed on similar surfaces with the tensiometer or ring method. They are, however, more readily studied with the film balance. Instead of only the fraction of a sec. predicted from simple diffusion, surfaces of solutions of hydrocinnamic acid require 1 000–2 000 mins. to arrive at their steady surface tension. When the surfaces of these solutions or of aerosol OT are suitably reduced in area, a pellicle is formed which will not dissolve unless a definite pressure is exceeded. For dilute solutions of aerosol OT this pressure is at a max. for a surface 75% compressed. Observations were also made with KCl and sodium silicate. With $N/1\,000$ KCl solution compression of the surface appears to produce a temporary surface pressure. AUTHORS.

1458. Ring method for the determination of interfacial tension. H. H. ZUIDEMA AND G. W. WATERS. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 312–313, *May* 15, 1941.—Evaluation of a correction factor for the method used in studying small changes in concentration of impurities during the refining of petroleum or in following the deterioration of hydrocarbon oil, either in accelerated stability tests or in actual service. ED.

1459. Determination of the surface tension and angle of contact of a liquid. A. E. BATE. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 403–409, *July*, 1941.—The theory is based on the large sessile drop. The expressions $h^2 + d^2 = 4a^2(1 + 2a/3r)$ and $\cos\theta = (d^2 - h^2)/(d^2 + h^2)$ are derived, in which h is the height of a drop of the liquid and d is the depth of a bubble formed in the liquid beneath a horizontal plane; a^2 is $T/g\rho$, T being the surface tension required, and r the horizontal radii of the drop and bubble, assumed to be the same and at least 6 cm. in length. The first expression is independent of the angle of contact θ, and the second is independent of the surface tension and density, ρ, of the liquid. Actually the latter expression is true for bubbles of infinite extent only, but the error incurred in using it for finite bubbles of the radius mentioned is a fraction of 1% of $\cos\theta$. The methods of developing the drop and bubble and of measuring h and d are described; preliminary results indicate that benzene and water have definite angles of contact with plate glass. AUTHOR.

1460. Properties of the electrical double layer at a mercury surface. I. Methods of measurement and interpretation of results. D. C. GRAHAME. *J. Amer. Chem. Soc.*, **63,** *pp.* 1207–1215, *May*, 1941.—A clear distinction must be made between the several kinds of capacitance which may be encountered in a study of the properties of the electrical double layer. A technique is described whereby accurate values of the differential capacitance of the double layer may be measured. Equations are given whereby the static capacitance and the surface charge may be calculated from several independent kinds of data. Results of such measurements are given for a number of solutions. An incipient precipitation of certain anions gives rise to large values of the capacitance of the double layer under appropriate conditions. The reversible electro-reduction of an ion gives rise to phenomena which simulate the behaviour of a condenser of very large capacitance. AUTHOR.

1461. Electrophoretic studies of nylon. M. HARRIS AND A. M. SOOKNE. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 289–292, *April*, 1941.—The surface electrical properties of unoriented and of highly oriented nylon fibres were investigated by a microelectrophoretic technique. Both types of fibres exhibited definite reversals of charge but at different *p*H values—the unoriented fibre at *p*H 3·9 and the oriented at *p*H 2·7. Since nylon consists of hydrocarbon chains linked together by amide groups, it appears that reversal of charge is principally dependent on the presence of the amide groups, especially since hydrocarbons do not exhibit reversal of sign of charge under comparable conditions. This suggests that amide groups may also influence the electrophoretic behaviour of other substances, such as proteins. The difference in the electrophoretic behaviour of the two types of nylon is attributed to the difference in their degrees of crystallinity. [See Abstr. 341 (1941)]. AUTHORS.

TIME.

***1462. Quartz clock and standard frequency generator.** L. ROHDE AND R. LEONHARDT. *Elekt. Nachr.-Techn.*, **17,** 6, *p.* 117, 1940. *Bull. Assoc. Suisse Élect.*, **32,** *pp.* 49–51, *Feb.* 14, 1941. *In German.*—The fundamental principle of this new piece of apparatus is the direct control of a tuning-fork generator with a fundamental frequency close to 1 kc./s. by a quartz-crystal oscillator of frequency 100 kc./s. By distortion of the wave form given by the tuning-fork generator and subsequent selection and amplification, the 100th harmonic is obtained and applied together with the crystal frequency through a rectifier to the control coil between the prongs of the tuning fork, which is thus maintained exactly at the 100th subharmonic of the quartz crystal. The controlled frequency is used to drive a 1 kc./s. synchronous motor and clockwork. A quartz bar is used, mounted *in vacuo* (0·1 mm. Hg) and with its temperature-coefficient reversal point at the working temperature. With thermostat control the accuracy of the time indications given by the clock is within 0·002 s. per day. On the axis of the synchronous motor is mounted a small dynamo which furnishes a frequency of exactly 50 c./s., which can be used as a frequency standard. A. W.

VISCOSITY AND FRICTION.

1463. Frictional rupture of large molecules. Proposed explanation of depolymerizing action of

supersonic waves. G. Schmid. *Phys. Z.*, **41,** *pp.* 326–337, *July* 1 *and* 15, 1940. *In German.*—The author develops a theory of supersonic depolymerization in which large molecules are broken down by frictional forces which arise in a solution which is vibrating strongly. At approx. gel concentration neighbouring parts of the solution vibrate with different amplitudes because of the influence of the large molecules on the density and elastic properties of the liquid. The free solvent may be regarded as vibrating through the meshes of a stationary rigid network of large molecules and bound or immobilized molecules of the solvent. Because of its inertia or rigidity, the network cannot follow the h.f. vibrations. The relative motion of the solvent and the large molecules gives rise to frictional forces which grind up the large molecules as in a mortar. The author computes that the frictional forces developed in this way on long thread-like molecules are sufficient to break the chemical bonds. On this simple concept it is possible to understand and correlate diverse experimental results in supersonic depolymerization. According to the mathematical development, the speed of h.f. waves in the given solutions depends on the frequency. An observable supersonic dispersion is therefore predicted for certain highly polymeric solutions. Such a phenomenon might be the basis of a new method of investigating the properties of solutions with large molecules.

G. P. H.

1464. Viscosity determination of cellulose. E. Berl. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 322–326, *May* 15, 1941.

* **1465. The S.I.L. viscometer.** E. L. Ruh, R. W. Walker and E. W. Dean. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 346–349, *May* 15, 1941.—A cinematic viscometer was developed and proved practical in actual routine testing operations. It is almost, if not fully, as satisfactory as a more expensive patented instrument of foreign origin which has been extensively used. Authors.

* **1466. Viscosity measurement.** M. R. Cannon and M. R. Fenske. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 299–300, *May* 15, 1941.—Describes a modification of the Ostwald viscometer which is particularly suited for measuring the viscosities of opaque liquids. Ed.

ASTRONOMY AND ASTROPHYSICS.

COMETS AND METEORS.

1467. Corrections to published analyses of meteorites. E. P. Henderson. *Amer. J. Sci.*, **239,** *pp.* 407–411, *June*, 1941.—A number of published analyses of Fe meteorites give Ni contents inconsistent with metallurgical structures; new analyses are recorded, of importance for the relationship between the etch pattern of meteorites and their chemical composition. New analyses for Glorieta, Grant, Mt. Joy, Sandia Mountains, Coahuila and Iquique are reported. Chemical evidence is given why Santa Fé is now considered to be a portion of the Glorieta. Author.

1468. Composition of the Maria Elena meteorite. V. B. Meen. *Amer. J. Sci.*, **239,** *p.* 412, *June*, 1941.

NEBULAE.

1469. Physical processes in gaseous nebulae. XII. Electron densities of some bright planetary nebulae. D. H. Menzel and L. H. Aller. **XIII. Electron temperatures.** D. H. Menzel, L. H. Aller and M. H. Hebb. **XIV. Spectrophotometry.** L. H. Aller. **XV. Statistical equilibrium of netural He.** L. Goldberg. *Astrophys. J.*, **93,** *pp.* 195–201, *Jan.*, *and pp.* 230–248, *March*, 1941.—The electron densities of some typical bright planetary nebulae were estimated from the intensity of the continuous emission beyond the limit of the Balmer series. The densities so obtained are of the order of 10^4 electrons/cm.^{3} for the objects studied and are probably somewhat lower in the fainter planetaries.—The temperatures were determined from the relative intensities of the line λ 4363 and the green nebular lines of O III. The values obtained range from about 6000°K. to 10000°K., and seem to be insensitive to the degree of excitation of the nebular spectrum and probably also of the temperature of the central star.—Total intensities of emission lines were determined from spectrograms made with the quartz slitless spectrograph attached to the Crossley reflector of the Lick Observatory. The plates were measured with the microdensitometer of the Harvard Observatory. Intensities of all the strong lines between λ 5007 and λ 3133 are tabulated. Intensities of lines in the visual region of NGC 7027, 7662, and 7009 have also been measured.—The He atom was assumed to contain an infinite number of energy levels, but a single equation of equilibrium was written down for all triplet levels above 2 $^3P^\circ$, and, similarly, for all singlets above 2 $^1P^\circ$. Mean values are thus obtained for the populations of the high singlets and the high triplets. The population is given in terms of a quantity b_n, the ratio between the true population and the value for thermodynamic equilibrium at a temperature T_e. The temperature T_e refers to an assumed Maxwellian distribution of the free electrons. The nebular atoms are assumed to be opaque to the stellar radiation field only in the frequencies corresponding to absorptions from levels 1^1S, 2^1S, and $2\,^3S$. Numerical solutions of the equations are tabulated for stellar temperatures, T_1, of 50 000° and 100 000° and electron temperatures of 5 000°, 10 000°, 20 000°, 40 000° and 80 000° and also for the special case $T_1 = T_e = 20\,000°$. AUTHORS.

1470. Reynolds number for extragalactic nebulae. F. ZWICKY. *Astrophys. J.*, **93**, *pp.* 411–416, *May*, 1941.—A programme is outlined to analyse the structure and the internal motions of nebulae in terms of the hydrodynamics of models composed of viscous compressible fluids. It is also indicated what types of refinements of the theory may be obtained through the application of statistical mechanics and of particle mechanics. The first indispensable cornerstone for the hydro-dynamic analysis of nebulae is laid through a discussion of the range of the Reynolds number R both for the stellar systems proper and for the systems of interstellar gases which may be present in the form of a matrix of a stellar system. It is shown that in many cases $R \gg 100$, which means that turbulent flows will play a major rôle in the morphology of nebulae. AUTHOR.

See also Abstract 1441.

PLANETS.

1471. Theory of the origin of the planets. R. A. LYTTLETON. *Astrophys. J.*, **93**, *pp.* 267–274, *March*, 1941.—Criticism of the double-star hypothesis as a basis of the theory of the origin of the planets is considered [Abstr. 2764 (1940)]. The dynamical criticisms urged by Luyten are shown to have arisen as a result of wholly inaccurate dynamical arguments given by him and by Hill. The mass of the planetary filament initially set free need not greatly exceed the mass of the present planets. The primitive planets did not necessarily retain the atmosphere-forming materials; these could escape to form a medium round the Sun and be picked up subsequently. The assumptions of the theory must not be confused with the essential dynamical constants, such as the masses of the stars involved and their initial velocities. It is improbable that the older difficulties concerning angular momentum of the planets could be overcome by changing the laws of mechanics without at the same time introducing comparable alternative difficulty with regard to certain of the satellite orbits. AUTHOR.

1472. Planetary atmospheres and water-cell temperatures. A. ADEL AND C. O. LAMPLAND. *Astrophys. J.*, **93**, *pp.* 391–396, *May*, 1941.—One of the most important quantities appearing in the relationship between water-cell transmission W and planetary temperature T is the water-cell transmission of the planetary reflected sunlight. In the absence of information regarding the nature of planetary atmospheres it has been assumed in the past that the sunlight was unmodified in quality by the reflection process. To the extent to which we are now aware of atmospheric composition within the solar system it is shown in this paper, which describes experiments carried out at the Lowell Observatory, that the solar radiation is significantly modified in quality by reflection and absorption. AUTHORS.

1473. The importance of certain CO_2 bands on the temperature radiation from Venus. A. ADEL. *Astrophys. J.*, **93**, *pp.* 397–400, *May*, 1941.—There is sufficient CO_2 in the Earth's atmosphere to absorb completely the fundamental emissions ν_2 (14·97 μ) and ν_3 (4·27 μ) from the atmosphere of Venus. It is pointed out, in consequence, that upper-stage bands of the types $\nu_3 \rightarrow (\nu_1, 2\nu_2)$ (near 10 μ) and $(\nu_1, 2\nu_2) \rightarrow \nu_2$ (near 13 μ) determine the quality of the radiation. It is shown that the latter is appreciable in amount and is highly selective in distribution. AUTHOR.

1474. On the observable radiation from the CO_2 in the atmosphere of Venus: comments on Adel's paper. C. O. LAMPLAND. *Astrophys. J.*, **93**, *pp.* 401–402, *May*, 1941.

1475. Theory of the divisions in Saturn's rings. G. R. GOLDSBROUGH. *Philos. Trans. A*, **239**, *pp.* 183–216, *April* 30, 1941.—In an earlier paper [Abstr. 493 (1922)] the author proposed a theory of the rings which showed satisfactory agreement with observed measurements. The mathematical method was, however, subjected to criticism. In the present paper the subject is again attacked by an entirely different method which is free from the objections raised against the first method. A family of periodic orbits of the particles forming the ring, when perturbed by a satellite, is constructed, and the stability of these orbits is examined by the method of small displacements. Stability determined in this way is shown to have a real meaning when applied to the problem in hand. The positions of instability of the particles lead to the divisions in the ring and the inner and outer boundaries, close agreement with observation being obtained. The analysis, though quite different from that of the earlier paper, reproduces its main features and introduces further points of interest. AUTHOR.

1476. The reciprocity principle in lunar photometry. M. Minnaert. *Astrophys. J.*, **93,** *pp.* 403–410, *May,* 1941.—In order to ascertain the exact meaning of the optical reciprocity principle, stated by Helmholtz, some simple idealized experiments are considered. By applying this principle to the case of a scattering surface a general reciprocity law, independent of the nature of the surface considered, is found. Definite relations must, therefore, exist between the brightness of 2 points on the Moon, if the lunar surface at these points has identical properties; a photometric test for this identity is thus obtained. From the work of Öpik, Fessenkoff and Bennett, examples are selected in which similar lunar formations are found to have similar surface layers, and other examples in which the surfaces are found to be different. The reciprocity principle restricts the possible forms of the general law of illumination of the lunar surface. Some of the laws thus far proposed are incompatible with it. Author.

STARS.

1477. Dynamics of the interstellar medium. I. Local equilibrium. L. Spitzer, Jr. *Astrophys. J.*, **93,** *pp.* 369–379, *May,* 1941.—The physical properties of the interstellar medium, especially those which depend on the presence of small dust particles, are examined in detail. It is shown that if the electron density is as great as 10^{-3} per cm.^{3} the charge on a dust particle will be determined by collisions with rapidly moving electrons rather than by photo-electric ionizations; a small particle will, in such a case, be charged to -2 V, independently of its radius. Any deviations from equipartition of kinetic energy between all the interstellar particles will be reduced by $1/e$ within at most 10^4 years if there is 1 proton per cm.^{3}, and within 4×10^5 years if no ionized H is present but if 10^{-3} Ca^{++} ions per cm.^{3} or their equivalent are assumed. The random velocities of dust particles should, therefore, be extremely small, and the m.f.p. should not be greater than a few astronomical units. The viscosity of the interstellar medium is evaluated and is shown to be negligible; in the neighbourhood of stars whose random motion does not exceed 10 km./sec. the medium will not acquire any net momentum. The rate of diffusion of interstellar particles is also very low, and mixing of the various constituents in 10^9 years is restricted to a few parsecs. Author.

1478. Stream-motions of 92 656 stars. W. J. Luyten. *Astrophys. J.*, **93,** *pp.* 250–266, *March,* 1941.—The estimated directions of motion of 92 656 stars in the southern hemisphere, mainly brighter than the 16th photographic magnitude, have been analysed by means of the empirical methods of Kapteyn and Eddington and the analytical method of Schwarzschild. The apex of drift I is found to lie at $\alpha=95^\circ$, $\delta=-15^\circ$; that of drift II at $\alpha=228^\circ$, $\delta=-69^\circ$; the solar antapex at $\alpha=104^\circ$, $\delta=-43^\circ$; and the vertex of star-streaming at $\alpha=263^\circ$, $\delta=-17^\circ$. The ratio of the numbers of stars belonging to each drift is found to be 0·59 : 0·41, with a sampling error of less than 0·003. A similar discussion dealing with 850 stars with $\mu > 0''{\cdot}5$ gives for drift I: $\alpha=99^\circ$, $\delta=-12^\circ$; for drift II: $\alpha=241^\circ$, $\delta=-70^\circ$; for the solar antapex: $\alpha=110^\circ$, $\delta=-38^\circ$, $q=0''{\cdot}61$; and a ratio of 2 : 1. A number of odd stars are singled out, for which the parallaxes should be larger than average. Finally, the motions of 830 double stars with common proper motion are analysed, and the apices of the two drifts are found to lie at $\alpha=96^\circ$, $\delta=-9^\circ$, and $\alpha=250^\circ$, $\delta=-71^\circ$, respectively, while a ratio of 0·63 : 0·37 is indicated. Author.

1479. Studies of faint B-type stars. C. K. Seyfert and D. M. Popper. *Astrophys. J.*, **93,** *pp.* 461–474, *May,* 1941.—Magnitudes, colour indices, spectral types and radial velocities, have been determined for 118 B-type stars, mostly between photographic magnitudes 9·0 and 11·0. A solution for galactic rotation, with $A=17{\cdot}5$ km./sec./kpc., yields a mean distance of the stars of 1·9 kiloparsecs, and a K term of $-4{\cdot}4$ km./sec. Authors.

1480. Evolution of a peculiar stellar spectrum: Z Andromedae. P. Swings and O. Struve. *Astrophys. J.*, **93,** *pp.* 356–366, *March,* 1941.—The spectral lines of Z Andromedae have been measured on plates taken between May 12 and August 25, 1940, when the brightness had decreased to magnitude 9·7 after the outburst in 1939. The spectrum shows emission lines of a thin and dilute nebula and resembles the spectrum observed by Plaskett in 1923–1926. There is some evidence of a late-type companion, in addition to a hot nucleus, which resembles some of the slow novae, and a fairly pronounced P Cygni type spectrum of an expanding shell. The latter is a remnant of the shell which was formed in the outburst of 1939. The nebular spectrum shows strong forbidden lines, but there are relatively few stages of ionization, which shows that the nebula consists of a fairly thin layer. The intensity of the auroral transition of [O III], λ 4 363, is relatively strong—a phenomenon which is characteristic of other binaries of similar type, and of novae. Among the nebulae the stellar planetary IC 4 997 shows the same feature. A list of lines of this object is given. Authors.

1481. Spectra of 2 peculiar stars: MWC 17 and CD–27°11944. P. Swings and O. Struve. *Astrophys. J.*, **93,** *pp.* 349–354, *March,* 1941.—

Wavelengths and radial velocities of emission lines in the peculiar stars MWC 17 and CD−27° 11 944 have been tabulated. The former is interesting because it contains forbidden [Fe III] and [Fe II], which places it between RY Scuti and η Carinae. The spectrum also shows H, He I, N II, N III, O II, Si II, [N II], [O I], [S II], etc. CD−27° 11 944 is a P Cygni type star showing H, He I, Fe II, Ca II, Na I, N II, and very weak [Fe II]. The dilution effect is small for He I, while the presence of forbidden [Fe II] suggested great distance from the photosphere. It is probable that this apparent discrepancy is caused by stratification. There is some suspicion that both stars may possess red companions. AUTHORS.

1482. Recent shell spectrum of γ Cassiopeiae. R. B. BALDWIN. *Astrophys. J.*, **93**, *pp.* 333–335, *March*, 1941.—Spectrograms of γ Cassiopeiae taken since the early part of 1939 give evidence of an extensive outer shell of gas. Strong absorption lines of H, He I, and Fe III are produced in the shell. Weaker lines of other elements are also found. The lines show that there is an appreciable dilution of the photospheric radiation. An analysis of the shell spectrum is given. AUTHOR.

1483. Emission lines in the spectra of B 1985 and WY Geminorum. P. SWINGS AND O. STRUVE. *Astrophys. J.*, **93**, *pp.* 455–460, *May*, 1941.—The spectra of B 1 985 and WY Gem show numerous emission lines in the ultra-violet region. These have been identified with [Fe II], Fe II, [Cr II], and Cr II. The permitted lines of Fe II and Cr II are relatively much stronger in B 1 985 than in WY Gem. Lines of high excitation potential are relatively weaker in the stars than in the laboratory. The strength of forbidden [Fe II] in the shells of these stars suggests that the lifetimes of the metastable levels are considerably shorter than those of metastable levels of [O I], [N II], [S II], etc. AUTHORS.

1484. The visual spectrum of Pleione. J. L. GREENSTEIN. *Astrophys. J.*, **93**, *pp.* 453–454, *May*, 1941.—The spectrum of Pleione is compared with that of α Cygni in the visual region. The shell lines are dominantly of Fe II, Mg I and Na I; they show almost no systematic velocity displacement. Lines arising from non-metastable levels are weakened; for example, Si II is extremely shallow and broad. The dilution, however, is only moderate. AUTHOR.

1485. Spectrum of the shell of Pleione. O. STRUVE AND P. SWINGS. *Astrophys. J.*, **93**, *pp.* 446–452, *May*, 1941.—The absorption spectrum of the shell of Pleione, which made its appearance in 1938, has a radial velocity of + 10·3 km./sec. It shows sharp cores of the Balmer lines as far as H_{31}. Mg II 4 481 and Si II 4 128, 4 131 are weak, probably because of the dilution of the exciting radiation. The lines of Ni II, Fe II, and Cr II are relatively strong; those of Ti II and Mn II are very weak; Fe I, Mg I and Sr II are present. The lines of Fe II give an excitation temperature of about 17 000°. The ionization is greater than in the shell of 17 Leporis, but not all intensities are accounted for by the ionization theory. The dilution factor is of the order of 0·1. From the state of ionization the electron pressure, estimated to be of the order of 0·5 bar in 17 Leporis, is probably appreciably higher in Pleione. Geometrical considerations suggest a value of $P_e = 0{\cdot}1$ bar. The shells of stars like Pleione are not unlike the reversing layers of normal supergiants. But the stars inside these shells belong to the main sequence. The shells form a spectral sequence which runs parallel to the normal stellar sequence from the early B's to the late A's. The ionization of the shells is lower than that of the corresponding stars. AUTHORS.

1486. The 1914 shell spectrum of ζ Tauri. R. B. BALDWIN. *Astrophys. J.*, **93**, *pp.* 420–424, *May*, 1941.—The spectrum of ζ Tauri is characterized by numerous sharp absorption lines produced in an outer shell of gas. In 1914 these shell lines were very strong. This paper presents an analysis of the 1914 spectrum and compares it with the weaker shell spectra of 1921 and 1926. AUTHOR.

1487. Absorption spectra of gases in the extreme ultra-violet. T. TAKAMINE AND Y. TANAKA. *Contrib. Mt. Wilson Obs. No.* 645. *Astrophys. J.*, **93**, *pp.* 386–390, *May*, 1941.—Absorption spectra of H, He, Ne and A in the extreme ultra-violet were photographed by means of a vacuum spectrograph with a concave grating of 20 cm. radius at grazing incidence. Lyman continuum, obtained by passing a heavy condensed discharge through a quartz capillary tube, was used as the background. Except for H, the spectrograph was filled with each of the gases at various pressures. Resonance series of He, Ne and A, were photographed in absorption. In the experiments on H, dry H at about 1 mm. pressure was kept flowing through the discharge tube. Production of atomic H by a hot filament of W placed in front of the quartz capillary seemed to help in suppressing the absorption bands of molecular H; and in that way 7 members of the Lyman series were obtained in absorption. Another interesting feature observed was the transparency of He for the He continuum. This was tested by passing a disruptive discharge through the He tube which served as the source of light for the He continuum, the spectrograph being filled at various pressures. No marked weakening of the He continuum was observed even at a fairly high pressure in the spectrograph. This fact is of significance because it proves beyond doubt that the so-called He continuum is of molecular origin. AUTHORS.

1488. Displacements of lines in the spectra of long-period variables. P. W. Merrill. *Contrib. Mt. Wilson. Obs. No.* 644. *Astrophys. J.*, **93,** *pp.* 380–385, *May*, 1941.—Wavelengths of absorption lines in Me spectra suitable for velocity measurements with moderate dispersion are listed. Data concerning periodic variations in the displacements of the dark lines, although meagre, indicate that, within 2 months of max. light, changes in velocity do not exceed a few km./sec. The mean measured displacements of the dark lines are assumed to represent the true stellar velocities. The emission lines, as is well known, are regularly shifted 0·1 or 0·2 Å toward the violet with respect to the absorption spectrum. These shifts, measured in 72 stars, are plotted against spectral type and against period. The relationship with period furnishes the best method of correcting the radial velocities determined from bright lines alone. Author.

1489. Interstellar line intensities and the distances of the B stars. J. W. Evans. *Astrophys.* J., **93,** *pp.* 275–284, *March*, 1941.—The relations between the intensities of the interstellar *D* and *K* lines and the distances of the O and B stars were determined. Distances derived from the rotational-velocity displacements of the interstellar lines were used. The relations appear to be approx. linear and are represented by the formulae $r = 2{\cdot}38D$ and $r = 3{\cdot}00K$. The mean error of an individual distance derived from either of these formulae is about 20%. A separate study of the stars of large and small colour excess confirmed previous conclusions by other investigators that there is no spatial relation between the interstellar atoms and the particles responsible for the photo-electric colour excesses. A comparison of colour excess with Joy's coefficient of photographic absorption yielded a value of 7·9 for the ratio Δ_{ph}/E, in good agreement with the value 8·6 predicted by the λ^{-1} law of selective absorption. The dispersion in the absolute magnitudes of the O and B stars of a given spectral subdivision and line quality was estimated to be $\pm 1{\cdot}3^M$, which corresponds to a mean error of a factor of nearly 2 in photometrically calculated distances. Author.

1490. Intercomparison of various spectral classifications of faint stars. A. N. Vyssotsky. *Astrophys. J.*, **93,** *pp.* 425–441, *May*, 1941.—The comparisons involve 8 500 stars from the 7th to the 13th magnitude; of these 5 500 have been classified at the McCormick Observatory especially for this purpose. The results are summarized. In general it may be said that all systems of classification agree at A0, with the exception of faint Potsdam stars; in other classes corrections must be applied to convert the spectral classification from one system to another. As far as can be determined, there is no magnitude error in the Henry Draper Extension (Nos. 1, 2, and 5), the Bergedorf, Mount Wilson, and McCormick classifications. Potsdam is also free from magnitude error for classes later than F8. A marked difference is found between the systems of the Henry Draper Catalogue and the Henry Draper Extension (Nos. 1, 2, and 5) in the later spectral classes. It is shown that corrections derived from a single regression curve will always over-correct, unless the accidental errors in the standard system are unusually small. Author.

1491. Light-curve of the eclipsing variable 29 Canis Majoris. C. K. Seyfert. *Astrophys. J.*, **93,** *pp.* 442–445, *May*, 1941.—At the McDonald Observatory during the years 1939 and 1940 150 observations of 2 or 3 exposures each were obtained with a 6 in. telescope. Certain anomalies in the form of the light-curve are mentioned; 3 solutions were made for the ellipticity and eclipse of the components. Author.

1492. Ratio of interstellar absorption to reddening. J. L. Greenstein and L. G. Henyey. *Astrophys. J.*, **93,** *pp.* 327–332, *March*, 1941.—Spectrophotometric investigations of reddened B stars have determined the law of variation of the interstellar absorption with wavelength, except for an additive constant. The uncertainty of the order of magnitude of any possible non-selective absorption appears in the ratio of absorption to reddening, a quantity of great practical importance. It is shown that the ratio of the intensities, at 2 wavelengths, of the total light from stars of a given type depends on the intrinsic colour of the stars and on the ratio of the interstellar absorption coefficients at those 2 wavelengths. The ratio of the interstellar absorption coefficients at the 2 effective wavelengths of the photo-electric colour indices determined by Stebbins, Huffer and Whitford, is evaluated. The non-selective absorption is found to be small or zero. The ratio of photographic absorption to photo-electric colour excess is found to be 8·1 ± 0·4. Authors.

1493. Radiation pressure in the convective stellar model. L. R. Henrich. *Astrophys. J.*, **93,** *pp.* 483–501, *May*, 1941.—The investigation of the effect of radiation pressure in the point-source model requires a study of the effect of radiation pressure in the convective model. The equations of state and of equilibrium are, therefore, derived for the wholly convective model with radiation pressure. Tables obtained by integrating these equations for various values of the ratio of the radiation pressure to the gas pressure at the centre are given. A relation is also obtained between the mass, the mean mol. wt. and the central value of the ratio (radiation pressure) / (gas pressure).

Since in the limiting case of vanishing radiation pressure the model reduces to the convective polytrope, it is possible to consider the actual density distribution with small amounts of radiation pressure as a perturbation of the polytropic case. The necessary first-order equation is obtained and integrated. AUTHOR.

1494. Distances and luminosities of 3 Novae. D. B. MCLAUGHLIN. *Astrophys. J.*, **93**, *pp.* 417–419, *May*, 1941.—The residual radial velocities of interstellar Ca lines in the spectra of v356 Aquilae, Nova Monocerotis 1939 and Nova Ophiuchi 1919, are interpreted as being due to the galactic-rotation effect. On the assumption of a uniform distribution of Ca along the line of sight, the following distances, r, and absolute magnitudes, M (corrected for absorption), are derived: v356 Aql, $r = 1\,700$ pc, $M = -5{\cdot}5$; Nova Mon 1939, $r = 1\,300$ pc, $M = -6{\cdot}8$; Nova Oph 1919, $r = 300$ pc, $M = -6{\cdot}6$. AUTHOR.

1495. The time of relaxation of stellar systems. I–III. S. CHANDRASEKHAR AND R. E. WILLIAMSON. *Astrophys. J.*, **93**, *pp.* 285–326, *March*, 1941.—The problem of the time of relaxation T_E of a stellar system is formulated *de novo* and solved from the point of view of the energies exchanged between stars during encounters. The method consists in evaluating the sum $\Sigma \Delta E^2$ (where ΔE is the energy exchanged during a single encounter idealized as a 2-body problem) for all possible encounters of an incident star during its motion through other field stars and determining its rate of increase with time. The formula for T_E is applied for the conditions prevailing in the galaxy and in the globular clusters.—The problem is considered from the point of view of the deflections suffered by stars during encounters. The method consists in evaluating the sum $\Sigma \sin^2 2\Psi$ (where $\pi - 2\Psi$ is the true deflection experienced by a star in a fixed frame of reference as a result of a single encounter idealized as a 2-body problem) for all possible encounters of an incident star, and determining its rate of increase with time.—Certain difficulties of principle which confront a rigorous and satisfactory analysis of stellar encounters within the framework of a theory which idealizes them, individually, as 2-body problems are pointed out. AUTHORS.

1496. Luminosities of the non-variable c stars. R. E. WILSON. *Contr. Mt. Wilson Obs. No.* 643. *Astrophys. J.*, **93**, *pp.* 212–228, *March*, 1941.—The mean absolute magnitudes of non-variable c stars have been determined from radial velocities (205 stars) and proper motions (241 stars). The value derived from all the stars is $\overline{M} = -4{\cdot}40$. It is found, however, that the stars with early-type spectra are much brighter than those of late type, the values of $\overline{M}$ decreasing continuously from $-5{\cdot}4$ for type B0 to $-2{\cdot}0$ for type K5. The spectrum/luminosity relation for the Cepheids, the spectra of which on low-dispersion spectrograms are quite similar to those of the non-variable c stars, runs in the opposite direction. The conclusion is that within this rather rare class of stars there exist 2 luminosity sequences, in one of which the stars are essentially non-variable, while in the other all are subject to a single type of light variation. AUTHOR.

1497. Theoretical synthesis of supernova spectra. F. L. WHIPPLE AND C. PAYNE-GAPOSCHKIN. *Proc. Amer. Phil. Soc.*, **84**, *pp.* 1–32, *April*, 1941.—The authors assume that the spectra of supernovae consist of permitted emission lines of astrophysically common elements, broadened by Doppler effect corresponding to an expansion of 12 000 km./sec. and superposed on a continuous background. Theoretical determinations are made of the relative line intensities in 19 spectra of atoms and ions, and the spectra are then combined at various levels of ionization, widening the lines in proportion to wavelength and then summing the intensities at small wavelength intervals. The resulting synthesized spectra bear a general resemblance to observed supernovae spectra, though H is probably less abundant and Fe more abundant than in ordinary stars and novae. The peculiar red shift with time observed only in the blue region of the spectrum is probably a fortuitous effect due to temperature changes. The results suggest that a supernova outburst is similar to that of a nova but on a larger scale. A. HU.

1498. Extension to the supergiants of the cyanogen criterion of stellar luminosity. P. C. KEENAN. *Astrophys. J.*, **93**, *pp.* 475–482, *May*, 1941.—The behaviour of CN in stars of accurately known spectral types and absolute magnitudes is studied by combining intensity estimates of the bands at λ 3 882 and λ 4 215. When plotted against spectral types, the observed band intensities show progressively earlier max. in going from dwarfs to supergiants. The usual equations of dissociative equilibrium can be extended successfully to the atmospheres of the supergiants to account for the observations. The absolute max. in CN intensity is reached near type K1 by stars with abs. magnitudes in the neighbourhood of -2. For types G4–K1 the luminosity effects in the bands are strong enough to allow good spectroscopic absolute magnitudes to be determined from their intensities. G-type stars of high luminosity are easily detected, even with very low dispersion, by picking out spectra with intense CN bands; and in this way discovery surveys can be extended to faint apparent magnitudes. AUTHOR.

GEOPHYSICS.

GEOPHYSICS, APPLIED.

1499. Electrical measurements in physical soil research. B. Marsch. *Elektrizität i. Bergbau*, **15,** *pp*. 17–21, *March*, 1940. *In German.*—A survey of the different methods used in tracing water, oil and ore layers, underground by surface investigations. The principles of resistance measurements leading to sounding and mapping are briefly dealt with. The instruments for d.c. and a.c. measurements using current electrodes and voltage sounds or induction frames with 2-phase compensators and amplifiers are described. The principles of the seismic methods are given, in which refraction or reflection are investigated by oscillograms and the nature of the strata is determined by the velocity of sound. A Bibliography is given. R. N.

LAND, PHYSICS OF THE.

1500. Some experiments on the consolidation of clay. L. F. Cooling and A. W. Skempton. *J. Instn Civ. Engrs*, **16,** *pp*. 381–398, *June*, 1941.—Experiments on the consolidation of London clay show that (1) time/consolidation curves give reasonable agreement with theory; (2) rate of consolidations varies inversely as the square of the thickness of the sample; (3) the coefficient of consolidation is a constant for the material and independent of the pressure; (4) the pressure/void relation is independent of the thickness. W. A. R.

1501. Consolidation settlement under a rectangular load distribution. M. A. Biot. *J. Appl. Phys.*, **12,** *pp*. 426–430, *May*, 1941.—The author's general theory [Abstr. 539 (1941)] is applied to the calculation of the settlement through consolidation of a soil loaded uniformly on an infinite strip of constant width with particular reference to the nature of the settlement at the edge of the loaded area. The solution is obtained by first calculating the settlement produced by a suddenly applied load with sinusoidal distribution. The use of a Dirichlet integral and the principle of superposition leads directly to the solution for the discontinuous loading. Author.

See also Abstract 1455.

METEOROLOGY.

1502. The stratosphere and an introduction to the design of stratosphere aeroplanes. R. R. Shuster. *J. Instn Engrs, Aust.*, **13,** *pp*. 89–97, *April*, 1941.—A summary of meteorological facts relating to aviation in the tropopause and substratosphere is given, special attention being paid to the temperatures, pressures and densities prevailing there, and to the oxygen and moisture contents and wind directions and velocities. Physiological considerations are reviewed in a section devoted to the design of pressure suits and cabins. The design of engines and superchargers for use at high altitudes is considered, and aerodynamical problems of wing loading and propeller design are also discussed. A. Hu.

1503. Variations of atmospheric temperature with altitude in U.S. H. W. Tenney. *Trans. Amer. Inst. Elect. Engrs*, **60,** *pp*. 230–231, *May*, 1941.

***1504. Heat radiation telescope and measuremen of infra-red emission of the atmosphere.** W. M. Elsasser. *Mon. Weath. Rev., Wash.*, **69,** *pp*. 1–5, *Jan.*, 1941.—An instrument is described in which total radiation is received by a blackened silver disc at the focus of a concave mirror directed towards the source. A similar compensating plate shielded from the source is heated electrically to balance the temperature rise of the receiver, balance being indicated by 2 thermocouples opposed in series. The process of calibration is described in full since the compensating heating system does not render periodic checks unnecessary. The emissivity of moist air is measured with the instrument by the Hottel method and is given as a function of the water vapour content. Deviations from the calculated values are discussed. A. Hu.

1505. Table of $\sqrt{(2/\rho)}$ for atmospheric air. T. Asano. *Mem. Ryoj. Coll. Engng*, **13,** *pp*. 237–271, *June*, 1940.

1506. Investigations on diurnal variation of barometric pressure in tropical seas. H. Jameson. *Quart. J. Roy. Met. Soc.*, **67,** *pp*. 157–162, *April*, 1941.

1507. Hurricanes into New England. C. F. Brooks. *Rep. Smithson. Instn*, *pp*. 241–251, 1939. —The meteorological sequences during the hurricane of Sept. 21, 1938, are described for the Blue Hill Observatory, and general pressure, wind, and rainfall maps are given for the N. Atlantic coast of the U.S. The conditions in which a W. Indian hurricane will strike this coast are given, and recommendations made for the establishment of warning services to prevent in future the heavy loss of life which occurred. Cloud observations and radiometeorograph soundings are particularly needed. A. Hu.

1508. African origin of hurricane of Sept. 1938. C. F. Brooks. *Trans. Amer. Geophys. Un.*, *pp*. 251–253, 1940.

1509. Distortion of the hurricane San Felipe (II) by mountains of Puerto Rico. R. G. Stone. *Trans. Amer. Geophys. Un.*, *pp*. 254–255, 1940.

1510. Effects of shearing motion on propagation of waves in prevailing westerlies. M. A. GARSTENS. *Pap. Phys. Oceanogr. Met., Massachusetts*, **8,** [32 *pp*.], *April*, 1941.—The semi-permanent centres of action often appear at upper levels as sinusoidal disturbances of the average zonal distribution of pressure. The paper discusses mathematically the effect of shear on the movement of such perturbations in the prevailing westerlies. The method of circulation integrals is applied to single and double horizontal layers, both infinite and finite; and the wave velocities, the lengths of stationary waves and the critical wavelengths, are computed for the various cases. The critical wavelengths are a measure of the instability arising from the action of shear and are found to compare favourably with the sizes of eddies found on the isentropic charts. A. HU.

1511. Anemometry: a critical and historical survey. P. A. SHEPPARD. *Proc. Phys. Soc., Lond.*, **53,** *pp*. 361–390, *July*, 1941.

1512. Meteorology of great floods in eastern U.S. C. F. BROOKS AND A. H. THIESSEN. *Rep. Smithson. Instn, pp*. 325–348, 1938.—The authors trace the development of the main floods in the eastern U.S. during the last 50 years in an effort to find the cause of the disastrous Ohio flood of Jan., 1937. The main cause of all such floods is the occurrence of a persistent high-pressure area over the W. Atlantic which sends wet tropical air inland to be elevated by the polar masses over the same area for days in succession. Flood control measures suggested include hindering the run-off by dense evergreen vegetation and by upstream dams, and constructing river levees lower down, by-passed by relief lowlands. Long-range forecasting will help the intelligent operation of control dams and diversions. A. HU.

1513. Formation of cloud and rain. G. C. SIMPSON. *Quart. J. Roy. Met. Soc.*, **67,** *pp*. 99–134, *April*, 1941.—In this presidential address the author describes what is known and what remains to be known on the subject. Evidence is set forth on the following outstanding problems: the nature and origin of the large nuclei ($d > 2 \times 10^{-5}$ cm.) on which cloud particles form (sea salt, combustion nuclei, or natural HNO_2); the mechanism of ice-crystal formation from supercooled water drops (spontaneous freezing or sublimation on nuclei) and the rôle of ice crystals and liquid cloud particles in the formation of raindrops. A. HU.

1514. Sea-salt and condensation nuclei. G. C. SIMPSON. *Quart. J. Roy. Met. Soc.*, **67,** *pp*. 163–169, *April*, 1941.—It is shown that the nuclei for normal cloud formation cannot be derived from sea-spray, since sufficient spray cannot be produced for this purpose. The amount of chloride present in rime and rain can be explained by assuming that the spray leaves in the air relatively large aggregations which provide the quantity of salt observed but not the number of nuclei required. The relationship between visibility and relative humidity which indicates a constant nuclear size below 70% humidity cannot be explained by the evaporation of a salt solution. A. HU.

1515. Turbulence and growth of cloud drops. D. ARENBERG. *Bull. Amer. Met. Soc.*, **20,** *pp*. 444–448, *Dec.*, 1939.—The author discusses the possibility that turbulence is a major factor in producing active precipitation. Equations are developed giving the path difference between a particle in a viscous medium and the medium itself for any turbulent change of velocity. At high degrees of turbulence and for fine-grained turbulence the rate of coalescence can exceed that due to gravity, particles of unequal size being brought together because of unequal rates of readjustment to turbulent motion. A. HU.

1516. Variability of precipitation. V. CONRAD. *Mon. Weath. Rev., Wash.*, **69,** *pp*. 5–11, *Jan.*, 1941. —Annual rainfall which is seriously variable (such as that on Malden I. where a 20 : 1 variation is recorded) presents an interesting climatological problem, which is here discussed statistically. The measures of variation used are the relative variability and the anomalies of variability, the latter being preferred as being a physical, as distinct from a statistical, entity. From observations at 384 stations it is deduced that the distribution of anomalies over the earth's surface represents a significant climatological element. Zero-isanomals of the relative variability are given on a world map and discussed in relation to climate. A. HU.

***1517. Further experience with shielded precipitation gauges on Blue Hill and Mount Washington.** C. F. BROOKS. *Trans. Amer. Geophys. Un., pp*. 482–485, 1940.

1518. Distribution of the average depth of snow on ground in New York and New England (II): curves of average depth and variability. R. G. STONE. *Trans. Amer. Geophys. Un., pp*. 672–692, 1940.

1519. Köppen classification of climates in N. America. E. A. ACKERMAN. *Geogr. Rev.*, **31,** *pp*. 105–111, *Jan.*, 1941.—Shortcomings of the Köppen climatic classification are discussed. In its main outlines it is defended from both the quantitative and the empirical standpoints. A new Köppen map is given for the N. American continent, embodying new climatological data and slightly revising the criteria of classification. The map appears in the text and also in folio form. Revision of the criteria for the C/D boundary is applied also to Europe and China. A. HU.

1520. Spectrum of the night sky. C. T. Elvey, P. Swings and W. Linke. *Astrophys. J.*, **93,** *pp.* 337–348, *March,* 1941.—A conservative list of lines in the spectrum of the night sky is given, using spectrograms obtained at the McDonald Observatory with the nebular spectrograph. The identifications are discussed, and the attention of the laboratory spectroscopists is called to the various experimental problems connected with this question. The main features of the spectrum of the night sky are represented by the atomic lines of Na I and [O I] and the band spectrum of N_2, particularly the Vegard-Kaplan and the First Positive systems. Estimates of the relative intensities of some of the lines show that the Na line is weak during the summer. Also, it was found that the Na line was enhanced in a luminous area of the night sky. The estimates of intensities of the forbidden O lines show that the red line, λ 6300, is very strong at the end of twilight and decreases to a more or less constant value around midnight, while the green auroral line shows the tendency to reach a max. shortly after midnight, as many others have observed. Authors.

***1521. Radio equipment for an un-manned weather station.** C. B. Pear, Jr. *Bull. Amer. Met. Soc.*, **21,** *pp.* 107–110, *March,* 1940. [Abstr. 1154 B (1941)].

SEISMOLOGY.

1522. The very large Pacific earthquake of Nov. 10, 1938. S. M. Mukherjee and M. R. Rangaswami. *Bull. Seism. Soc. Amer.*, **31,** *pp.* 121–128, *April,* 1941.

1523. Seismological station of University of Pittsburgh. D. C. Bradford. *Bull. Seism. Soc. Amer.*, **31,** *pp.* 101–106, *April,* 1941.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

***1524. Field equipment for ionosphere measurements.** T. R. Gilliland and A. S. Taylor. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 377–384, *May,* 1941.—Field equipment for the automatic recording of virtual heights and critical frequencies of the ionosphere layers is described. Such equipment is useful for special investigations, such as during solar eclipses, to supplement the systematic recording which has been in progress at Washington since 1932. A frequency range from 790 to 14000 kc./s. is covered. Only 1 min. is required for the recording cycle. Records are made on 35 mm. positive film. The transmitter is pulsed by means of a thyratron and resistance-capacitance network controlled by a magnetic synchronizing device. The equipment is mounted in an automobile trailer and is complete, including a primary source of power. Authors.

1525. The great magnetic storm of 1941, March 1. *Observatory,* **64,** *pp.* 82–86, *June,* 1941.

RADIOACTIVITY.

1526. Evaluation of the surface area of catalysts of cubic form by the emanation method. J. D. Kurbatov. *J. Phys. Chem.*, **45,** *pp.* 851–866, *May,* 1941.—Correct application of the emanation method for evaluating surface area requires the incorporation of radium and thorium X simultaneously in order to determine, from the measurable radon and thoron, that part of the emanation which escapes by diffusion and that which escapes from recoil. On the assumption that the solid consists of separate and perfect cubes, the surface area can be evaluated if the range of recoil and the percentage of recoiled emanation are known. H. H. Ho.

1527. Calculation of absorption in Ra preparations of high concentration. H. Fränz and C. Weiss. *Phys. Z.*, **41,** *pp.* 345–348, *Aug.* 1, 1940. *In German.*—Measurement of the active content of Ra preparations requires consideration of the γ-ray absorption in the salt itself. The authors have already described 2 ways to make this correction experimentally in the case of material of low Ra content [Abstr. 3826 (1935)]. These methods are not applicable if the Ra content is high. The absorption, which may be neglected in the usual clinical case where the layer of the preparation is thin or of bulk and concentration similar to the standard of comparison, must be taken into account if the preparation is of greater mass than the standard, whether because of poor concentration or of high Ra content. For this correction the absorption coefficient μ and the absorption function must be known. Such an absorption function has been derived for the case where the radioactive material is in spherical form. A cylindrical container is, however, customary. There is an available absorption function for cylindrical form: $I/I_0 = 1 - 8\mu R/3\pi + \mu^2 R^2/2 - \dots$

in which I/I_0 represents the ratio of the radiation which issues from the preparation to the total radiation emitted and R is the radius of the cylinder. In practice this formula cannot be used because the radium preparation is in a partially filled cylindrical container whose axis is horizontal. For this case the authors derive an appropriate formula. The absorption coefficient μ may be found from the electron density if the composition of the salt is known. Otherwise μ can be obtained from the apparent density ρ and the mass absorption coefficient μ/ρ, which may be taken as 0·050 g.$^{-1}$cm.^{2} If the mass of the active substance is unknown, the components $RaCl_2$ and $BaCl_2$ may be estimated by comparison with a pure $RaCl_2$ standard and μ found by the method of Béhounek [Abstr. 666 (1935)]. The above correction formula must be applied both to the unknown and to the standard. A numerical example is given in which the net correction in the computed Ra content of the unknown amounts to + 1%.

G. P. H.

1528. Precise measurements of the energies of β-rays from radium (B + C). A. F. A. Harper and N. F. Roberts. *Proc. Roy Soc. A,* **178,** *pp.* 170–188, *June* 12, 1941.—[See Abstr. 2022 (1937), 1086 (1934), 1206 (1924)]. Measurements have been made of the $H\rho$ of 11 β-rays of radium B and of 1 of radium C. The values are based on 11 photographs of the spectra taken with a spectrograph of the type used by Ellis, and 10 photographs with a spectrograph of the type introduced by Scott, the field strengths used ranging from 190 to 1 050 G. The values obtained agree closely with those of Rogers for the lines measured by him. The energies corresponding to the $H\rho$ values were calculated using weighted mean values of e/m and c given, respectively, by Bearden and von Friesen. The error in the energies is approx. 1 : 10^3. Measurement of the $H\rho$ of the same line for a number of widely differing values of H was a check on the presence of systematic errors, which had not been made by previous workers. An appreciable apparent increase of $H\rho$ with H was found, and a comparison of the calculated and observed line forms showed that this apparent increase is to be attributed to scattering of electrons in the emulsion. This effect appears to be one of the most important now limiting the accuracy obtainable by the present method. Authors.

1529. Radioactive determination of relative abundance of the isotope K^{40} in terrestrial and meteoritic potassium. W. C. Schumb, R. D. Evans and W. M. Leaders. *J. Amer. Chem. Soc.,* **63,** *pp.* 1203–1205, *May,* 1941.—KCl was separated from a sample of the Pultusk meteorite and its β-activity was compared with that of a terrestrial sample. Spectroscopic analyses indicated the two samples to be of high purity. The results indicate no difference in the proportion of K^{40} present in the two cases and, therefore, no difference in age within the limits of statistical error. Authors.

1530. Evidence for radioactivity of slow mesotrons. F. Rasetti. *Phys. Rev.,* **59,** *pp.* 706–708, *May* 1, 1941.—A beam of mesotrons is selected by means of a 4-fold coincidence system of counters and is allowed to pass through a block of iron 10 cm. thick. The absorption of mesotrons by the iron is recorded by means of a battery of anti-coincidence counters. It is found that a certain fraction of the stopped mesotrons is associated with the emission of an ionizing particle from the absorber. A special coincidence-recording system, whose resolving time is of the order of 1 μsec., indicates that the emission of the particles is delayed with respect to the passage of the mesotron by a few μsec. The delayed particles are interpreted as the electrons resulting from the β-decay of the mesotron. Author.

1531. The γ-ray transition of radio-bromine. R. E. Siday. *Proc. Roy. Soc. A,* **178,** *pp.* 189–201, *June* 12, 1941.—The disintegration by the emission of γ-rays of the metastable isotope of RaBr was investigated by the method of the cloud chamber. The principal γ-ray was found to have an energy of 47 kV and a coefficient of internal conversion in the K shell of 0·43. Confirmation of a weaker γ-ray of 37 kV was also obtained.

Author.

1532. Energy of the γ-rays from the disintegration of fluorine by protons and deuterons. W. E. Bennett, T. W. Bonner and B. E. Watt. *Phys. Rev.,* **59,** *pp.* 793–795, *May* 15, 1941.—The max. energy of the γ-rays from the disintegration of a thick target of F by protons has been determined at 0·90 and 1·7 eMV. The energy was found to be the same at both bombarding voltages. The γ-rays from the disintegration of F by deuterons were studied with 1·3 eMV deuterons and found to be complex and to have a max. energy of 6·7 ± 0·3 eMV. This indicates that the highly excited states of Ne^{20} at 9·0 and 10·1 eMV, which were found in the reaction $F^{19}(d, n)Ne^{20}$, break up into O^{16} and He^4 instead of emitting γ-rays.

Authors.

1533. Disintegration of carbon by deuterons. W. E. Bennett, T. W. Bonner, E. Hudspeth, H. T. Richards and B. E. Watt. *Phys. Rev.,* **59,** *pp.* 781–792, *May* 15, 1941.—The excitation curves for the emission of γ-rays, neutrons and protons, from the disintegration of C^{12} by deuterons are investigated. Resonances for γ-ray emission were found at 0·92, 1·16, 1·30, 1·43 and 1·74 eMV. The resonance at 1·43 eMV has a half-width less than 10 ekV while the other resonances are considerably broader. Resonances for neutron emission were found at 0·92, 1·16, 1·30, 1·74 and 1·82 eMV. Resonances for proton emission are found at 0·92, 1·16, 1·23 and 1·74 eMV. The γ-rays from C^{12} were shown to come from the reaction $C^{12}(d, p)C^{13*}$. The short-range protons from this reaction were observed and had a range of 1·1 cm. The Q value for this 1·1 cm. proton group is $-0{\cdot}52 \pm 0{\cdot}07$ eMV. The excitation curves for the emission of γ-rays and protons from the disintegration of C^{13} by deuterons were investigated. Both curves showed a resonance at 1·55 eMV deuteron energy. The γ-rays from C^{13} have an energy of 5·5 eMV and come from the reaction $C^{13}(d, n)N^{14*}$. The low-energy group of neutrons from this reaction were found when a 23% C^{13} target was used. The Q value for this group of neutrons is 0·40 eMV. The relative and absolute yields of the various reactions were determined. AUTHORS.

See also Abstracts 1380, 1381, 1382.

RADIATION.

ABSORPTION.

***1534. Grey filters for light from the ultra-violet to the infra-red.** H. THEISSING AND M. GOEBERT. *Z. techn. Phys.*, **21,** 7, *pp.* 149–153, 1940. *In German.*—Filters that have a constant absorption over the range of wavelength from 0·3 to 2·3 μ are described. They consist of two components—a metallic film and a film of carbon black, such that one has a high transmission coefficient in the wavelength region where the other has a high absorption coefficient. In another method this matching is obtained with 2 cathode-sputtered films of the same metal, one being more crystalline and the other more amorphous. J. J. W.

1535. Infra-red production, transmission, reflection and measurement. L. R. KOLLER. *Gen. Elect. Rev.*, **44,** *pp.* 167–173, *March*, 1941.—A summary under the above headings of available information concerning infra-red radiation, which also deals with the fundamental laws of radiation, contains a number of curves, and refers to 23 other publications. R. W. P.

COLORIMETRY.

1536. Colorimetric determination of phosphorus in steel and cast iron. J. L. HAGUE AND H. A. BRIGHT. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 405–413, *May*, 1941.—The phosphomolybdenum blue reaction is utilized, and the transmittancy of the coloured solution is measured with a photo-electric colorimeter and a Corning lantern shade yellow filter, No. 349. Provision is made for the effects of As and Si, and a method of compensating for the colour of alloying constituents is given. An accuracy of $\pm 0{\cdot}003\%$ was indicated for steels whose P content ranged from 0·01 to 0·11%. With cast irons containing 0·25 to 0·80% of P, values accurate to $\pm 0{\cdot}82\%$ were obtained. A single determination of P in steel can be made in about 20 min., and a set of 8 determinations can be completed in approx. 45 min. AUTHORS.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

1537. Phenomena accompanying the inverse Stark effect (electric double refraction). F. GABLER. *Phys. Z.*, **42,** *pp.* 67–72, *April*, 1941. *In German.*—A preliminary account of observations of the inverse Stark effect and its accompanying phenomenon (transverse electric double refraction near certain lines) in Na and K. The difficulties of an experimental investigation of this kind are overcome by using an atomic ray as absorbing layer, and especially in this way field-strengths up to 250 kV/cm. are attainable without special safety measures. Double refraction close to the Na D_2-line is readily proved by the method of crossed polarization prisms; no such effect is observable at D_1. Near the K resonance line $\lambda = 7\,645$ Å analogous to the D_2-line, also by a sensitive half-shadow method, no electric double refraction could be detected. H. G. S.

EMISSION.

1538. Radiation of furnace gases. H. C. HOTTEL AND R. B. EGBERT. *Trans. Amer. Soc. Mech. Engrs*, **63,** *pp.* 297–307, *May*, 1941.—Data of various investigators on the emission and absorption of radiation by CO_2 and H_2O vapour are reviewed critically. Recommendations of procedure in calculation of heat transmission by gas radiation are given. Partial pressure of water vapour affects gas radiation, but probably to a much smaller extent than has been reported in previous literature. A simplified procedure is presented to allow for the effect of the gas shape on radiant heat interchange. AUTHORS.

1539. Temperature radiation of solid insulators. (Selective radiators.) F. Möglich, N. Riehl and R. Rompe. *Z. techn Phys.*, **21**, 6, *pp*, 128–134, 1940. *In German.*—A qualitative discussion is given of the radiation of insulators as compared with the radiation of metals. The low emissivity in the near infra-red and the visible region is due to the fact that the energy bands are filled. Thus only ultra-violet emission should appear, due to the electrons jumping from one band to the next, and infra-red, due to the lattice vibrations. It is explained that at high temperatures there is a lack of sharpness in the definition of the bands with a consequent displacement of the ultra-violet emission bands towards the visible. J. J. W.

1540. Recurrence phenomena in cosmic-ray intensity. J. W. Broxon. *Phys. Rev.*, **59**, *pp.* 773–776, *May* 15, 1941.—The adaptation of Chree's method of analysing geomagnetic data, as carried out by Monk and Compton for their Mexican cosmic-ray data, has been applied to cosmic-ray intensity measurements at Boulder, Colorado. Secondary pulses in the cosmic-ray intensity are apparent in the difference curves. These occur at approx. 28-day intervals both before and after the primary pulse, in good agreement with the findings of Monk and Compton, but the Boulder pulses are somewhat smaller and more irregular. Within the 4 (previous and subsequent) pulse intervals investigated, magnitudes of the secondary pulses do not appear to depend upon the interval from the primary pulse. Author.

*** 1541. Investigation of the absolute determination of cosmic-ray coincidence with an amplifier of adjustable resolving power.** E. Weber. *Phys. Z.*, **41**, *pp.* 242–256, *May*, 1940. *In German.*—A double-coincidence amplifier is described in which the resolving power is independent of the counter discharges. This is accomplished by having the amplified counting pulses trip a thyratron circuit, giving pulses that are uniform and adjustable in size and duration, independent of the initiating discharges. The resolving time is adjustable between 10^{-4} and 5×10^{-7} sec. It is found that there exists a min. resolving time that depends on the dimensions, circuit and filling gas, of the tube counter. Absolute values for the resolving time of the amplifier are determined by making use of random coincidences. The circuit and counters are used to investigate large cosmic-ray showers; showers covering an area of 1 200 m.^{2} are found to be strongly absorbed by 10 cm. of lead. G. P. H.

1542. Coincidence amplifier with high resolving power. E. Weber. *Phys. Z.*, **41**, *pp.* 338–339, *July* 1 *and* 15, 1940. *In German.*—Further details are given for optimum performance of the high-resolution thyratron circuit [Abstr. 1541 (1941)]. The reaction time of the thyratron, from ignition until extinction, can be made less than 5×10^{-6} sec. by suitable choice of circuit constants. For clean-cut response under these conditions a relatively high grid bias of − 140 V is required on the thyratron, with the cathode at + 70 V instead of zero as in the previous article. As the screen-grids of the amplifier valves are at this same potential of 70 V, false coincidences occur, due to interaction through the voltage supply, unless this 70 V terminal is bridged to earth through a condenser of 0·5 μF. For continuous operation over long periods a sturdy mechanical counter is required. A sturdy counter may not be fast enough, in which case Forsman's scaling circuit is recommended because of its high resolving power [Abstr. 2977 (1938)]. The grid potential of this scaling circuit is critical, at about $-(25 \pm 10)$ V. With this scaling circuit 2 difficulties may arise: (1) At high resolution of the Rossi coincidence mixer the impulses to the scaling circuit are weak and of short duration. As the time constants of the grid circuits of the scaling circuit must be small, the scaling circuit may not respond. (2) For high resolution high grid bias is necessary in the actual counting circuit fed from the mixing stage. At the anode of the mixing valve the amplitude of a chance coincidence is dependent on the interval between the two separate discharges, increasing as the interval decreases. As the scaling circuit must have the given low grid voltage, chance coincidences are counted, with resultant resolution greater than 5×10^{-5} sec. These difficulties may be avoided by inserting an intermediate stage between mixer and scaling circuit, with such negative grid bias that weak impulses due to chance coincidences will be suppressed. Another way to obtain better resolution than 10^{-5} sec. with a scaling circuit is to replace the Rossi coincidence mixer by a hexode, as in Bothe's original double-grid coincidence circuit. G. P. H.

1543. Study of double coincidence arrangements. W. W. Dittrich. *Phys. Z.*, **41**, *pp.* 256–269, *May*, 1940. *In German.*—If 2 double-coincidence cosmic-ray counter sets are so arranged that they register as nearly as possible the same rays, there will be fluctuations in their readings due to particles that do not pass through both pairs of counters. These fluctuations are calculated for various geometrical arrangements of counters, and the results compared with the experimentally observed fluctuations. It is found that the calculated fluctuations are always smaller than the observed fluctuations by the same fraction; this is attributed to the imperfect efficiency of the counters and to absorption of the cosmic rays in the upper counters.

G. P. H.

***1544. New circuit for a thyratron-operated counting device.** J. SCHINTLMEISTER AND W. CZULIUS. *Phys. Z.*, **41,** *pp.* 269–271, *May*, 1940. *In German.*—A thyratron is used to operate a mechanical counter and is cut off after firing by a high-vacuum tube in its plate circuit. This vacuum tube is controlled in turn by a contact in its grid circuit that is closed by the mechanical counter; this contact is so arranged as to operate continuously for a long time (up to 1 month) without trouble. The resolving time of the circuit, as determined by connecting it to a tube counter, is 5×10^{-3} sec. The circuit can also be used to distinguish between input pulses of different sizes (α-particles, protons) by biasing the thyratron in such a way as to change its firing voltage. G. P. H.

***1545. The tube counter as measuring instrument.** W. KOLHÖRSTER AND E. WEBER. *Phys. Z.*, **42** *pp.* 13–19, *Jan.* 1, 1941. *In German.*—The investigation is concerned with the methods of carrying out measurements, particularly of cosmic rays, with tube counters. A large number of arrangements of tube counters with amplifiers and registering apparatus, employed by various investigators extending over several years, are critically examined. The conclusion is reached that with the arrangements described continuous registration of cosmic rays can be carried out and reproduced with a high degree of accuracy and constancy in no wise inferior to the results obtained with very good high-pressure ionization chambers, but these arrangements are essentially superior to ionization chambers, especially by virtue of the use of direction-sensitive tube counters and the coincidence method. H. G. S.

1546. Energy distribution and composition of primary cosmic-ray particles. N. HILBERRY. *Phys. Rev.*, **59,** *pp.* 763–764, *May* 1, 1941.—

See also Abstracts 1535, 1557.

FLUORESCENCE & PHOSPHORESCENCE. LUMINESCENCE AND AFTERGLOW.

1547. Photo-electric investigation of luminescent materials. L. BERGMANN AND F. RONGE. *Phys. Z.*, **41,** *pp.* 349–355, *Aug.* 1, 1940. *In German.*—A photovoltaic effect was investigated in 20 fluorescent and phosphorescent substances by the method originated by Bergmann [Abstr. 2994 (1932)]. Each specimen, in the form of a thin layer on a microscope cover-glass, was clamped between an Al plate and a thin transparent coating of Au in strips on a quartz plate. The electrodes of the condenser thus formed were connected to grid and cathode of the first valve of an amplifier. Radiation from an arc passed through a monochromator, was rendered intermittent with a frequency of 600 c./s. by a rotating sector and was incident on the quartz window of the cell. A motor simultaneously rotated the prism of the monochromator and a drum of photographic film on to which the output galvanometer of the amplifier reflected a point of light. A graph was thus automatically recorded, the co-ordinates being wavelength and amplified photo-electric current. These curves were redrawn to correct for irrational dispersion of the monochromator, spectral energy distribution of the source and distortion by the amplifier. A definite photo-electric effect was observed only for the 10 substances which showed practically no phosphorescence or very brief phosphorescence. In most cases the effect had unequal max. at 2 wavelengths in the near ultra-violet. The authors find that the max. occur at the wavelengths which produce max. fluorescence, and suggest that this method might be used to determine these wavelengths in cases where only a small quantity of material is available. The results are discussed with reference to motion of electrons according to theories of luminescence due to Lenard and Tomaschek. Quenching of a phosphor by infra-red radiation was investigated by irradiating the same cell simultaneously with intermittent infra-red radiation and continuous monochromatic radiation of slowly varied wavelength. The observed photo-electric effect showed strong max. at the same ultra-violet wavelengths of the steady radiation as in the previous experiment, although the amplifier could amplify only pulsating currents. In some cases, however, the primary and secondary max. were interchanged. G. P. H.

1548. Fluorescence and sensitivity of photographic gelatin films at low temperatures. W. MEIDINGER. *Phys. Z.*, **41,** *pp.* 277–285, *June* 15, 1940. *In German.*—The temperature-dependence of fluorescence in various silver-halide films has been studied down to the temperature of liquid air. In contrast to coarse-grain films, the fluorescence of fine-grain films of the same chemical constitution begins only at appreciably lower temperatures. The max. achievable quantum yield for coarse-grain films is approx. 1. Correspondingly, the sensitivity of fine-grain films drops more sharply with falling temperature than the sensitivity of coarse-grain films. Although the sensitivity of fine-grain films decreases monotonically with falling temperature, in coarse-grain films prepared with a large excess of KBr a large decrease with a subsequent slight rise at lower temperatures is observed. A comparison of the radiant energy stored in coarse-grain plates exposed in the fluorescence region with the density of the plates indicates that the latent Ag atoms are more dispersed at lower temperatures, thus permitting a more efficient development of the latent image. G. P. H.

INTERFERENCE, DIFFRACTION AND SCATTERING.

1549. Lloyd's single-mirror interference fringes. P. F. Titchmarsh. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 391–402, *July,* 1941.—Half of the central fringe of Lloyd's single-mirror system can be seen directly if the fringes are observed in a plane passing through the edge of the mirrors and if the mirror is of ordinary, not black, glass and has a cleanly cut edge which is illuminated by light shining on to the opposite edge. The use of mica to displace the fringe system is not valid since the central fringe will be displaced more for blue light than for red. This dispersion of the central fringes for the different colours may produce a displaced white-light system approx. symmetrical about a black fringe, but this black fringe will not be produced by the coincidence of the displaced central fringes. It is equally possible to find a thickness of mica which gives a displaced system symmetrical about a white fringe. The phase change on reflection at a less dense medium at grazing incidence is shown to be in the region of π, since a system with a black central fringe is formed when the mirror is immersed in CS_2. Author.

1550. Elementary theory of coronas of water droplets. T. A. S. Balakrishnan. *Proc. Indian Acad. Sci. A*, **13,** *pp.* 188–193, *March,* 1941.—In the usual theory of coronas the water droplets are regarded as opaque discs, but they are here treated as perfectly transparent spheres in passing through which the wave fronts undergo a phase retardation. An expression is derived for the intensity of the diffracted radiation, which is completely evaluated for the forward direction. A comparison with the usual formula for an opaque disc shows a difference which oscillates with increasing size of the drop and ultimately becomes very small. The colours observed in the central disc of the corona for small sizes are thus qualitatively explained. Author.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

1551. Contribution to measurement of actinic values of light sources. H. Korte and W. Meidinger. *Phys. Z.*, **41,** *pp.* 305–307, *July* 1 *and* 15, 1940. *In German.*—As the response of a photographic emulsion depends both on the characteristics of the source and on the spectral transmission of the lenses used, the transmissions of 10 photographic objectives were measured for wavelengths 366 mμ, 436 mμ and 578 mμ from a mercury arc with appropriate filters. The measuring instrument consisted of an Ulbricht integrating sphere of 10 cm. dia. with 7 selenuim blocking-layer cells, each 2 cm. in dia. The cells were in the hemisphere toward the source and were distributed around the 45 mm. hole through which the light entered, but were shielded from direct light by a sleeve in the opening. The other hemisphere was removable for optical adjustment. The results show that the transmission of the objectives in the visible is about 3 times as great as in the near ultra-violet. The objectives were mostly types whose transparence in the ultra-violet is relatively low because of the long optical path in glass. In more common objectives the said ratio τ_{578}/τ_{366} is closer to unity. Comparison of the DIN wedge and the objectives showed that they were completely comparable in transmission, indicating that the conditions with DIN 4 512 or 4 519 are very close to those of a practical exposure. Using wedge DIN 4 519, comparison of actinism of a 75 W clear glass Nitra lamp and an Osram HgQS 300 lamp (75 W ultra-violet transmitting glass bulb) showed that the two are about alike with a Pan film. A DIN light source was somewhat weaker. Sensitivity tests of various photographic emulsions (Agfa-Lupex, Agfa-Brovira, Agfa-ISS film) with a given source show that the differences in these sensitivities are least with a mercury arc, whereas they increase by a factor of 100 with a Nitra lamp. Values for a DIN lamp are intermediate. These results were to be expected from the spectral absorptions of AgCl, AgBr and the panchromatic emulsion. G. P. H.

***1552. Evolution of single-exposure colour camera.** J. H. Coote. *Photogr. J.*, **81,** *pp.* 293–302, *June,* 1941.—A historical survey of the evolution of single-exposure colour cameras. Full details are given of the arrangements of many of the cameras. A. H.

PHOTOMETRY.

***1553. Barrier layer photocell and filters as objective-type photometer.** J. Rieck. *Z. techn. Phys.*, **21,** 8, *pp.* 184–187, 1940. *In German.*—The author studies the spectral sensitivity of 2 photocells with filters, used in Germany: type 25F with filters given by Dresler and the Scher photocell with Lange filters, in comparison with the spectral sensitivity of the eye as given by the International Committee on Illumination. The correspondence is incomplete, but adding 4 Schott filters—OG4, OG5, VG4 and BG15—the two spectral sensitivities become very similar. J. J. W.

***1554. Simple photometer for the examination of X-ray films.** A. H. Jay. *J. Sci. Instrum.*, **18,** *pp.* 128–130, *July,* 1941.—Constructional details and experimental procedure are given for a simple photometer. The instrument can be used for identifying line patterns or making accurate intensity measurements. Photometer curves are shown of complex X-ray spectra. Intensity measurements and the necessary calculations are included for the determination of the atomic scattering factor of Al. AUTHOR.

***1555. Investigation of distribution of light in neighbourhood of the useful direction of a photometric standard lamp.** H. WILLENBERG. *Phys. Z.*, **41**, *pp.* 234–235, *May*, 1940. *In German.*—An incandescent lamp designed for photometric work has its filament wires arranged in a plane, and light emitted in a direction perpendicular to this plane is used. The intensity should be constant within 3° of this direction, but often is not, especially in the horizontal plane (filament wires vertical). The light distribution in a horizontal plane within 5° of the perpendicular to the filament plane is measured by a sensitive photocell, the output equal to that from the perpendicular direction being compensated out. For cylindrical lamps with internal glass filament supports stray reflections produce deviations of more than 1% from the perpendicular value. Pear-shaped and conical lamps having partially blackened walls are much more uniform, one of the latter varying by 6 parts in 10 000 at 5° from the perpendicular. G. P. H.

1556. Carbon arc as a standard of light. J. T. MACGREGOR-MORRIS. *Trans., Illum. Engng Soc., Lond.*, **5**, *pp.* 123–138, *Dec.*, 1940.—The first part of this paper consists of a detailed summary of previous work on the arc and its possibilities as a standard of luminous intensity. The research described in the body of the paper is a study of the bright comma-shaped patch which rotates over the surface of the positive crater when the arc is operated at such a current density that it commences to hum. The influence of resistance, inductance and capacitance on this comma and its rotation have been investigated. It is found that the direction of rotation can be reversed by a tangential jet of air or by an axial magnetic field of the right direction. The stronger this field the higher the frequency of rotation. The proportionality between crater area and current and between luminous intensity and current which has been found to hold for a silent arc continues to hold when the arc commences to hum. J. W. T. W.

***1557. New hydrogen lamp as a source of continuous ultra-violet light.** W. WEIZEL, H. ROHLEDER AND H. FINKEN. *Z. techn. Phys.*, **21**, 5, *pp.* 101–103, 1940. *In German.*—A new hydrogen lamp of the hollow-cathode type is described. It is water-cooled, can be taken apart easily and operated on a.c. at pressures between 2 and 5 mm. Hg. Its brilliance is said to be 20 times that of the Hauf-Buest lamp. J. J. W.

POLARIZATION.

1558. Polarographic behaviour of histidine and certain other amino-acids. E. R. ROBERTS. *Trans. Faraday Soc.*, **37**, *pp.* 353–357, *July*, 1941.—Histidine, when analysed polarographically, exhibits 3 characteristic effects, 2 of which, under specific conditions, are proportional to the concentration of histidine. One of these effects persists and retains proportionality in presence of arginine and lysine. This wave may be utilized for analytical purposes. Cystine determinations must be made on freshly prepared solutions. Serine, tryptophane and tyrosine do not lend themselves to polarographic estimation. AUTHOR.

***1559. Use of a filter based on rotatory dispersion.** F. GABLER. *Phys. Z.*, **41**, *pp.* 339–341, *July* 1 *and* 15, 1940. *In German.*—For measurement of strong birefringence, or for precise determination of optical rotation, the mercury green line at 5461 Å cannot be sufficiently well isolated by the usual filters, which transmit too much of the continuous red radiation emitted by the hot envelope of the mercury arc. Glass, gelatine or liquid filters, which do eliminate the red also weaken the green line excessively. To avoid these difficulties the radiation was sent through a polarizer, a quartz plate cut perpendicular to its optic axis and an analyser which could be rotated in azimuth. The thickness of the quartz plate was so chosen that the rotation for the desired wavelength λ, which the filter is to transmit, differs by 90° from the rotation for the wavelength λ_2 which is to be eliminated. The unwanted radiation can thus be extinguished by suitable setting of the analyser. The thickness of the quartz plate is computed from the relation $d = 90/(\alpha_1 - \alpha_2)$, where α_1 represents the specific rotation of the quartz for wavelength λ_1 and α_2 for wavelength λ_2. Actually a band of wavelengths in the neighbourhood of λ_2 will be substantially weakened in calculable ratios. The author has used this apparatus also to eliminate unwanted lines in overlapping grating spectra of different orders. A quartz plate of variable thickness, like the Soleil double wedge, is proposed for use at various wavelengths. G. P. H.

REFLECTION, REFRACTION AND DISPERSION.

1560. Inter-reflections in finite cylinders. P. MOON. *J. Opt. Soc. Amer.*, **31**, *pp.* 223–233, *March*, 1941.—The solution is obtained of the integral equation determining the luminosity distribution due to inter-reflections in a right cylinder of finite length and with end discs. The cylindrical surface and the ends are assumed to have constant but different reflection factors and initial luminosities. It is also assumed that the kernel of the integral equation can be represented to a sufficient approximation by the expression $Ae^{-a|s-t|}$. The approximation is good for the circular cylinder. For other cross-sections—ellipse, rectangle, triangle, hexagon—the luminosity varies round the cylinder at constant depth but there is theoretical and experimental evidence that the variations are unimportant, and they are ignored. The solution for the circular cylinder then applies to any cross-section if the unit of length is reduced in the ratio 1 to $p/(2S)$, where p is the perimeter and S the cross-sectional area. For the case of a rectangular section this leads to the simplifying scale derived empirically by Hisano. Simpler forms of the solution appropriate to special cases, e.g. open ends, are derived. Application to light distribution in rooms is discussed. W. S. S.

1561. Inter-reflections in light-wells. P. Moon. *J. Opt. Soc. Amer.*, **31,** *pp.* 301–308, *April*, 1941.—The solution of the integral equation for inter-reflections in finite cylinders is applied to light-wells of rectangular section. The error involved in representing the kernel by a single exponential term is discussed. It is shown that, except in light-wells of small depth, the luminosity falls off exponentially with distance from the top. Satisfactory agreement is obtained with experimental results due to Meacock and Lambert and with values calculated by Manning and White using a method of numerical approximation. The theory gives too low a luminosity deep down in the well, especially when the bottom has a high reflecting factor. An improved approximation is obtained, using the exact expression for the direct illumination on the bottom. Assuming that the wall luminosity in the well should not fall below a certain fraction, say 0·1, of the sky luminosity, the theory gives the max. permissible depth of a well of given cross-section for different reflection factors of walls and bottom. The appropriate curves are determined for certain cases. W. S. S.

1562. Calculation of light distribution in light-wells. W. T. White. *J. Opt. Soc. Amer.*, **31,** *pp.* 308–317, *April*, 1941.—Numerical solutions of the integral equation determining the luminosity due to inter-reflections in light-wells are obtained by use of the cinema integraph. This instrument gives directly the value of the integral $\int_a^b f(x,t)g(x)dx$ where $f(x,t)$ and $g(x)$ are prescribed functions. The cases computed are: (*a*) right circular cylinder, depth equals twice diameter, reflection factor unity; and (*b*) wells of rectangular section 1 × 1, 1 × 2, 1 × 5, depth 4, reflection factor 1·0, 0·8, 0·5, 0·25. The correct algebraic expressions are used for the kernel and not the exponential approximation. Good agreement is obtained with the experimental and calculated results of Meacock and Lambert and Manning and White, respectively. When the reflection factor is unity the luminosity falls off almost linearly with depth, and for this case calculations of high accuracy can be obtained by a perturbation method. W. S. S.

1563. Inter-reflections in rooms. P. Moon. *J. Opt. Soc. Amer.*, **31,** *pp.* 374–382, *May*, 1941.—The solution of the integral equation for inter-reflections in right cylinders of any cross section leads to relatively simple equations for the calculation of illumination and luminosity in rooms with flat ceilings. These equations are used in calculating the average illumination on a horizontal plane, the luminosity distribution on the walls of the room, the average luminosity of the ceiling and the average luminosity of the floor. The effects of changing the reflection factors of ceiling, walls and floor, are considered, as are the effect of changing the height of the working plane and the effect of changing the room shape. Author

1564. Optical reflection factors of acoustical materials. P. Moon. *J. Opt. Soc. Amer.*, **31,** *pp.* 317–324, *April*, 1941.—Measurements were made of the reflection factor throughout the visible spectrum of 100 acoustical materials, all of rough porous structure with some sound-absorbing properties. The incident light was nearly normal and the whole of the reflected light, including any spectacular reflection, was included. From the results the total reflection factor for 2 842° radiation (illuminant "A") and the trichromatic coefficients were computed. The unpainted "white" or near-white materials have rather low reflection factors and the white painted materials are inferior to ordinary surfaces coated with modern white paints. All materials reflect poorly in the blue end of the spectrum. Calculation shows that normal variations of the colour temperature of white light (2 000° to 10 000°) have almost negligible effect on the reflection factor. All the materials are "dirt-catchers" and in use the reflection factor would deteriorate. No measurements were made on used specimens. W. S. S.

1565. Combination of optical systems. S. Rosin and O. H. Clark. *J. Opt. Soc. Amer.*, **31,** *pp.* 198–201, *March*, 1941.—A method is given for determining the cardinal points of a combination of $n+1$ co-axial optical systems by the analysis of a characteristic nth-order determinant discovered by Ferraris. The determinant is made up of the principal diagonal occupied in order by the separations of the consecutive systems (image focal point of the first to object focal point of the second) and of the two adjacent diagonals occupied respectively by the image and object focal-lengths, omitting those of the first and last systems: zeros elsewhere. The lateral magnification for any pair of conjugate points produced by the entire system is given by 2 simple expressions involving the characteristic determinant, and from these the resultant cardinal points can be derived. The method is applied to determine the cardinal points of Gullstrand's schematic eye. W. S. S.

1566. Unit planes in an optical system including a plane-parallel plate. K. Pestrecov. *J. Opt. Soc. Amer.*, **31,** *pp*. 338–341, *April,* 1941.—It is shown that the unit planes of a plane-parallel plate of thickness t are at infinity and are separated by a distance t if the plate is regarded as the limit of a lens with surfaces of equal curvature tending to zero, but are located symmetrically within the plate at a separation $t-t/n$ if the lens surfaces have equal but opposed curvatures. It is further shown that the two solutions give identical positions for the resultant unit planes when the plate is combined with another optical system. W. S. S.

1567. The geometry of stereoscopic projection. J. T. Rule. *J. Opt. Soc. Amer.*, **31,** *pp*. 325–334, *April,* 1941.—The several geometrical considerations which enter into the practical problem of stereoscopic photography and projection are developed in a coherent scheme. In parallel projection the camera axes are parallel and separated by the interocular distance of the human eyes, and either the same is true of the projectors or the latter are "toed in" so that distant points in the picture are separated by the interocular distance on the screen. There is always a unique correct viewing distance yielding a stereoscopic image of the proper size, shape and location. For objects which appear in the plane of the screen the viewer's convergence and accommodation are correctly correlated, but for objects too far in front of the screen the correlation breaks down and eye strain sets in. This difficulty, which in practice eliminates close-ups, can be overcome by setting the camera lenses a distance apart greater than the interocular distance. In this way a steroscopic close-up, for example, of a human head filling a 15ft. screen can be obtained, but some observers notice at once that they are looking really at a giant 15ft. head. Moreover, depth perception in the stereoscopically magnified object is less than in the real object. Another way out is to use non-parallel projection, which has the effect of moving the stereoscopic image away from the observer. The projector axes must not diverge too much, however, or for some objects the viewer's eyes will be required to diverge. This limits the depth of scene. The method has other disadvantages, but it does not involve variable camera-lens separation. A final section describes the proper framing of the two stereoscopic pictures. W. S. S.

1568. Refractivity of LiF in the visible and infra-red region. H. Littmann. *Phys. Z.*, **41,** *pp*. 468–475, *Oct.* 15, 1940. *In German.*—The refractivity of LiF is determined spectrometrically with an accuracy of $\pm 2 \times 10^{-6}$ for 3 lines of the visible spectrum with a prism cut from an artificial crystal (the method of preparing these crystals will be described later by Smakula). By a spectrometric method and using the same prism the refractivity is measured in the region of 1·0 μ to 3·0 μ relative to the known dispersion curve of quartz. The accuracy of the method is $\pm 1 \times 10^{-5}$ to $\pm 2 \times 10^{-5}$. With a prism from the same melt a measurement of the temperature coefficient for the *D* line is made by the Pulfrich method with an accuracy of $\pm 0{\cdot}1 \times 10^{-6}$. H. G. S.

1569. Theory of transmission of light through inhomogeneous transparent layers. H. Schröder. *Ann. Phys., Lpz.*, **39,** 1, *pp*. 55–58, *Jan.*, 1941. *In German.*—A derivation is given of the Bauer approximation formula [Abstr. 2040 (1934)] expressing the reflecting power in inhomogeneous layers in terms of the refractive index of the support (glass), the ratio of the values of the refractive index of the layer at its surface boundaries, the mean refractive index of the layer, the layer thickness and the wavelength of the light. Its physical significance is pointed out. H. G. S.

1570. Spin structure of double refracting films of cellulose hydrate. H. Straub. *Z. techn. Phys.*, **21,** 7, *pp*. 154–156, *and* **21,** 8, *p*. 187, 1940. *In German.*—Films of cellophane are double refracting. They show a fibrous structure parallel to the electric vector of the slow wave. This structure produces a periodic difference of optical path when light traverses the film. Experimenting on $\lambda/4$ films, chosen among commercial cellulose hydrate films, the author obtains the average value of $1/100\,\lambda$ for the fluctuations in optical path due to the spin structure. J. J. W.

1571. Optical refraction patterns. I. Theory. R. S. Rivlin. *Proc. Phys. Soc., Lond.*, **53,** *pp*. 409–417, *July*, 1941.—In an earlier note the writer has described the formation of patterns by refraction of light, from a point source, at the surface of a ground surface of quartz parallel to the (0001) plane and has indicated that the method has been applied to the study of ground and scratched surfaces of quartz and other materials [*Nature, Lond.*, **146,** *p*. 806]. In the present paper a mathematical theory of the formation of these refraction patterns is given. Formulae are deduced and curves are given showing the relation between the intensity distribution in the refraction pattern formed by a surface uniformly covered by small facets, having any specified distribution of orientations, and this distribution of orientations. From a measurement of the light-intensity distribution in the refraction pattern the law of facet distribution with orientation may be calculated. It is intended, in subsequent papers, to discuss the application of these results to the interpretation of various refraction patterns. AUTHOR.

✱1572. A process for the continuous melting and drawing of tubes and rods of fused quartz and high-melting-point glasses. W. HANLEIN. *Z. techn. Phys.*, **21,** 5, *pp.* 97–101, 1940. *In German.*—With the mass production of high-pressure mercury lamps it has become necessary to obtain tubes of fused quartz of precise dimensions and clear material at low cost. A furnace is described which will do the job and constructional details of the apparatus are given. The temperature reaches 2000° to 2200°C. and tubes up to 4 mm. in dia. can be drawn. The same furnace has been used for high-melting-point glasses, whose expansion coefficients are measured. J. J. W.

See also Abstract 1535.

SPECTROSCOPY.

✱1573. Production of an energy-equalized spectrum. E. LAW AND H. THEISSING. *Phys. Z.*, **42,** *pp.* 61–63, *April*, 1941. *In German.*—A simple arrangement for producing an energy-equalized spectrum is described and schematically illustrated. A prism of low dispersion is interposed between the light source and the slit of the prism spectrograph so as to form on the slit an image of the source with coloured edges. The precautions and adjustments are stated. Curves are included showing the spectral distribution of the lamp used both before and after the interposition of the prism, as well as the additional effect produced with red and blue filters. The method of registration of the curves is explained and a device described for effecting a more rapid control and adjustment. H. G. S.

1574. True line width and oscillator strength of lines of Eu sulphate. G. JOOS AND K. H. HELLWEGE. *Ann. Phys., Lpz.*, **39,** 1, *pp.* 25–29, *Jan.*, 1941. *In German.*—The grating method of measurement is used by the authors in their determination of the spectrum of a crystal of $Eu_2(SO_4)_3.8H_2O$ and is fully described. Their preference for this method to the use of the spectrograph is discussed. Their results are embodied in the accompanying table, in which the $^7S_0$ of the original are replaced by $^7F_0$ as mentioned in a subsequent corrigendum by the authors [*ibid.*, **39,** 2, *p.* 128, *Feb.*, 1941]. A further correction given is that the ^7F on p. 26 of the original should be $^7F_0$. H. G. S.

Term combination	Wavelength at —190° C.	Wavelength at + 15° C.	Half-wave-length at + 15° C.	Oscillator Strength
	Å	Å	Sec.$^{-1}$	
$^7F_0-X_0$	5793·34	5790·90	$4·35\times10^{10}$	$1·39\times10^{-10}$
$^7F_0-X_1$	5262·52	5260·11	—	$5·5\times10^{-9}$
	5257·45	5255·60	$6·52\times10^{10}$	$1·87\times10^{-9}$
	5253·92	5251·95	$6·95\times10^{10}$	$2·32\times10^{-9}$
$^7F_0-X_2$	4659·96	4658·1	$15·2\times10^{10}$	$4·4\times10^{-9}$
	4654·08	4652·3	—	$10·6\times10^{-9}$
	4651·12	4649·5	$9·72\times10^{10}$	$2·2\times10^{-9}$
	4648·52	4647·0	—	$8·9\times10^{-9}$
	4644·12	4642·7	—	$7·7\times10^{-9}$

1575. Discontinuous molecular spectra. II. R. FRERICHS. *Phys. in regelmäss. Ber.*, **7,** 4, *pp.* 153–167, 1939. *In German.*—This review continues the previous report [Abstr. 5070 (1935)] till the beginning of 1939. The sectional headings given in the previous abstract are augmented by the following: spectra of polyatomic molecules, radicals, active modifications and flames. A special impetus was given to the investigations by the interest in the form and size of highly polymerized molecules. Absorption bands in the infra-red and ultra-violet ranges are dealt with. For the spectroscopical determination of molecular structure the change from H to D atoms was particularly fruitful. A Bibliography of 212 publications is given. R. N.

1576. Radiation measurements of hot gaseous flames with a photo-electric cell. R. MECKE AND H. KEMPTER. *Z. techn. Phys.*, **21,** 7, *p.* 156, 1940. *In German.* Corrigenda. [Abstr. 2460 (1940)].

1577. Excitation of emission spectra of organic molecules by electron collisions in a glow discharge. H. SCHÜLER, H. GOLLNOW AND A. WOELDIKE. *Phys. Z.*, **41,** 16, *Aug.* 15, 1940. *In German.*—A d.c. glow discharge tube is described which can be used to excite the emission spectra of organic molecules by electron collisions. The tube could be run under conditions of very little dissociation of the molecules. It was used to obtain the emission spectra of benzene, chlorbenzene, naphthalene and acetone, krypton being employed as a carrier of the discharge. In benzene a new region of continuous emission was observed from 2 700 Å to about 4000 Å. The conditions which result when a molecule absorbs light are somewhat different from those produced by electron collision. In benzene, for example, light is absorbed from 2470 Å to 2 220 Å, but no emission results from electron collisions in this region. In the case of chlorbenzene discrete bands are found in absorption in the region from 2760 Å to 2420 Å, but in emission there is a continuum in this region with no evidence for a discrete structure of the type found in absorption. Bands resulting from dissociation of molecules were obtained and were characteristic of the molecule. New emission bands of the molecule CO were observed in the region from 3 150 Å to 4 050 Å. G. P. H.

1578. The λ3105 band of OD. M. ISHAQ. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 355–361, *July*, 1941.—The λ3 015 band of OD has been photographed in the 4th order of a 10 ft. concave grating. The band, like that of OH at λ3 122, is the (1, 1) band of a $^2\Sigma^+ \rightarrow {}^2\Pi_{\text{inv.}}$ transition. An analysis of the rotational structure is made, and the values of the rotational constants are determined and compared with those for the corresponding OH band. AUTHORS.

1579. Infra-red spectra of SiH_4 and GeH_4. C. H. TINDAL, J. W. STRALEY AND H. H. NIELSEN. *Proc. Nat. Acad. Sci., Wash.*, **27,** *pp.* 208–212, *April*, 1941, Measurements have been made of the fundamental bands ν_3 in the spectra of SiH_4 and GeH_4. The effect of the gas pressure upon the appearance of the bands is discussed. The moments of inertia of the molecules and the Si–H and Ge–H distances are given. The reason for the appearance of a considerable amount of secondary structure cannot, as yet, be ascertained. A. H.

1580. Low terms in Co VII and Ni VIII. E. E. ANDERSON AND J. E. MACK. *Phys. Rev.*, **59,** *pp.* 717–723, *May* 1, 1941.—The levels $3d^3$ $^4FP^2$ GDH (and ^2P?) and $3d^2$ $4p(^3F)$ ^{42}GFH (^3P) ^4DPS (^1G) ^2HG are identified in Co VII and Ni VIII. The graphs of relative energy against Z for the even levels are, on the whole, smooth; but ^2G ^2H ^2D show marked and very similar irregularities, which remain unexplained. The doublet separations behave in a regular fashion. The sharp decline in certain of the odd levels, especially ^4FDDP, between Co VII and Ni VIII can be explained as due to the approach of (undiscovered) levels of the $3p^54d^4$ configuration, which are expected to cross $3d^24p$ near this stage of ionization. AUTHORS.

1581. Spectrophotometric determination of praseodymium, neodymium and samarium. C. J. RODDEN. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 557–570, *June*, 1941.—

1582. The spectrographic determination of potassium in leaf material. I. W. WANDER AND W. R. BRODE. *J. Opt. Soc. Amer.*, **31,** *pp.* 402–404, *May*, 1941.

1583. Continuous spectra. II. W. FINKELNBURG. *Phys. in regelmäss. Ber.*, **7,** 4, *pp.* 143–152, 1939. *In German.*—The report covers the literature published since the previous report [Abstr. 2229 (1936)]. The electron continua, viz., series boundary continua due to ionization in the ranges of visible and X-rays and their reverse, the emission series boundary continua and the brake continua, are dealt with. The theory of molecular continua has been improved and van der Waal's forces have been further investigated. The continuous spectra of Hg have been specially investigated. The author reports investigations on the carbon arc and on spectra emitted by flames, or generated by condensers discharged through fuses or in gases of low pressure, or by detonation waves. A Bibliography of 226 publications is given. R. N.

1584. The Stark effect and its relation to thermodynamic and magnetic effects in chrome alum at low temperatures. Z. W. KU. *Phys. Z.*, **41,** 11–12, *June* 15, 1940. *In German.*—An attempt is made to calculate the entropy and sp. ht. of chrome alum at low temperatures in terms of crystal forces by calculating the perturbing effect of the crystal potential on the spectroscopic ground state of the Cr^{+++} ion. The zero-order wave functions are taken to be orthogonal sets corresponding to ^4F terms in a M_LM_S representation and $^4F_{3/2}$ terms in a J M representation. The disturbing crystal potential is divided into 2 parts, one cubic and one trigonal in symmetry. Further, the Zeeman pattern is calculated and from this explicit formulae for the magnetic susceptibility are obtained, one of which obtains when the largest separation of levels in the Zeeman pattern is large compared with the separation produced by the Stark effect, and the other when the separation of levels in the Zeeman pattern is small compared with that in the Stark pattern. By means of van Vleck's dipole-dipole-coupling theory, explicit formulae for the entropy and sp. ht. of chrome alum in zero external field are obtained. G. P. H.

1585. Zeeman effect of the forbidden lines of Pb I. I. Pure quadrupole and magnetic dipole lines. F. A. JENKINS AND S. MROZOWSKI. *Phys. Rev.*, **59,** *pp.* 808–813, *May* 15, 1941.—[See Abstr. [248 (1941)]. A very intense source of the forbidden lines, consisting of a h.f. discharge through He containing a small amount of Pb vapour, is used to photograph the Zeeman patterns in fields up to 4000 gauss. Reproductions are given of the transverse effect for the main hyperfine component, due to the even isotopes, in a magnetic dipole line, λ 4618, and in 2 quadrupole lines, λλ 4659 and 5313. The reversal of polarization in λ 4618 is clearly shown. The splittings of the weaker hyperfine components emitted by Pb^{207} are also observed for λλ 5313 and 4618, including, in the latter case, fields strong enough to show the Back-Goudsmit effect. Splittings and intensities are in satisfactory agreement with theory throughout. These are the first observations on the Zeeman effect of the hyperfine structure of forbidden lines, and they establ[illegible]e applicability of the electric dipole intensity formulae (with interchange of polarization) to magnetic dipole lines and of the Rubinowicz quadrupole formulae with suitable substitution of quantum numbers to quadrupole lines. AUTHORS.

1586. Raman spectra of aldehyde and ketone bisulphites. C. N. CAUGHLAN AND H. V. TARTAR. *J. Amer. Chem. Soc.*, **63,** *pp.* 1265–1267, *May*, 1941.

1587. Raman spectra of acetylenes. IV. Carbon isotope effect in acetylenes. F. F. CLEVELAND AND M. J. MURRAY. *J. Chem. Phys.*, **9,** *pp.* 390–392, *May*, 1941.—The carbon isotope shift in the frequency near 2200 cm.$^{-1}$ is calculated for $H - C^{13} \equiv C^{12} - H$, $CH_3 - C^{12} \equiv C^{13} - H$, $CH_3 - C^{13} \equiv C^{12} - H$ and $CH_3 - C^{13} \equiv C^{12} - CH_3$ from the valence force equations, assuming a 4-mass, linear oscillator. The results are − 27, − 26, − 50 and − 33·5 cm.$^{-1}$ respectively. Weak lines which may correspond to isotope shifts are observed for the monosubstituted acetylenes, 1-heptyne (− 21 and − 53 cm.$^{-1}$), 4-methoxy-1-butyne (− 24 and − 53) and phenylethyne (− 24 and − 54), and for the disubstituted acetylenes, 1-phenyl-1-butyn-3-one (− 37), 1-phenyl-1-butynol-3 (− 33), 1-phenyl-1-butyne (− 29), 3-hexyne (− 26), 3-octyne (− 36) and 5-decyne (− 38 cm.$^{-1}$). [See Abstr. 810 (1941)]. AUTHORS.

1588. Hindered rotation in halogenated ethanes. G. GLOCKLER AND C. SAGE. *J. Chem. Phys.*, **9,** *pp.* 387–389, *May*, 1941.

1589. Physical interpretations of resolving power. B. P. RAMSAY, O. T. KOPPIUS AND E. L. CLEVELAND. *J. Opt. Soc. Amer.*, **31,** *pp.* 202–208, *March*, 1941.—Rayleigh's definition of spectroscopic resolving power is stated in various forms, including a form appropriate to the photon theory of light. It is shown that the relation: resolving power = (angular dispersion) × (width of incident wave front) holds for the Fabry-Perot interferometer as for the prism and grating. As an alternative definition of resolving power the expression $(\alpha/Y)(\Delta I/\Delta\alpha)$ is considered, where α is the epoch function (proportional to the order of interference in familiar cases)—$(\Delta I/\Delta\alpha)$ is the intensity epoch slope which depends on the effective number of interfering beams and on the precise criterion of resolution adopted. The quantity Y is left undetermined for the present but if Y is put equal to the max. intensity of the spectrum line the new definition gives the Rayleigh resolving power increased by 19%. W. S. S.

1590. Photon theory of optical resolving power. B. P. RAMSAY, E. L. CLEVELAND AND O. T. KOPPIUS. *J. Opt. Soc. Amer.*, **31,** *pp.* 296–300, *April*, 1941.—The relation between the intensity/epoch slope definition of spectroscopic resolving power and Rayleigh's definition is discussed in terms of the photon theory and the principle of indeterminacy. It is suggested that Rayleigh's definition is appropriate for the comparison of isolated spectroscopic devices while the new definition includes effects associated with the breadth of the spectrum lines of the source, the characteristics of the photographic plate, the sensitivity of the microphotometer, etc. W. S. S.

See also Abstracts 1411, 1487, 1669.

TRANSMISSION.

See Abstracts 1535, 1569.

VISION.

∗1591. Portable visual adaptometer. G. WALD. *J. Opt. Soc. Amer.*, **31,** *pp.* 235–238, *March*, 1941. The instrument was designed for use in a vitamin-A deficiency survey in N. Newfoundland and Labrador. The test patch and the red fixation light are illuminated by lamps whose intensities are varied together by means of a rheostat. The test patch is controlled by a photographic shutter giving exposure times down to 1/50 sec. Test-patch sizes up to 10° dia. and positions from 3° to 10° below the fixation point can be used. A funnel-shaped eyepiece protects the subject's eyes from stray light. The method of varying the intensity of the test patch involves colour as well as intensity change. The scale of the instrument is determined by direct measurements of test-patch brightness with an illuminometer. Details are given of the experimental procedure and of the scatter of the results. W. S. S.

X-RAYS.

1592. X-ray diffraction methods. B. E. WARREN. *J. Appl. Phys.*, **12,** *pp.* 375–384, *May*, 1941.—A discussion of the theory of the various methods of obtaining crystal diffraction patterns.

1593. Experimental technique in the study of alloys by X-rays. O. S. EDWARDS AND H. LIPSON. *J. Sci. Instrum.*, **18,** *pp.* 131–133, *July*, 1941. [Abstr. 1119 B (1941)].

1594. Applied X-rays. *J. Appl. Phys.*, **12,** *pp.* 362–413, *May*, 1941. [Abstr. 1120 B (1941)].

1595. X-ray analysis in industry. II. Technique of X-ray analysis methods and some recent developments. Photometry of X-ray crystal diffraction diagrams. J. M. ROBERTSON AND R. H. V. M. DAWTON. *J. Sci. Instrum.*, **18,** *pp.* 126–128, *July*, 1941.—X-ray crystal diffractions can be recorded on photographic films as spots, but these spots vary in area and are uneven in density. The first problem in any structural analysis is to obtain the integrated values of the intensities of the X-ray beams which produced the spots. The difficulties involved are outlined, and the various instruments which have been devised to perform this operation are briefly described. A new instrument, based on the principle of a rapid scan of the X-ray diffraction spot, similar to the scanning used in television, is also described. AUTHORS.

1596. The measurement of stress by X-rays. D. E. THOMAS. *J. Sci. Instrum.*, **18,** *pp.* 135–138, *July*, 1941.—A description is given of a method of applying precision back reflections to determine stress in metals by measuring changes in lattice dimensions. The method employs no reference material. AUTHOR.

1597. Particle-size measurement by the X-ray method. F. W. Jones. *J. Sci. Instrum.*, **18,** *pp.* 157–158, *July*, 1941.—The X-ray method of particle-size determination is briefly reviewed. A short summary is given of the theoretical work and the more important experimental methods. The accuracy and limitations of the method are discussed. Author.

See also Abstracts 1398, 1399, 1402.

HEAT.

CALORIMETRY.

***1598. Specific heats of some aqueous solutions of Na and K chlorides at several temperatures. III. Results for dilute NaCl solutions at 25°C.** C. B. Hess. *J. Phys. Chem.*, **45,** *pp.* 755–761, *May*, 1941.—A brief description is given of an adiabatic twin calorimeter having the calorimeter covers in thermal contact with the liquids in the calorimeters. The results of 39 runs on relatively dilute NaCl solutions at 25°C. are given. Compared with earlier work [Abstr. 1861 (1940)] some improvement in precision of measurement has been attained. Author.

***1599. Simple method of demonstrating decrease in specific heats of solids at low temperatures.** F. H. Müller. *Phys. Z.*, **41,** 11–12, *June* 15, 1940. *In German.*—An apparatus for demonstrating the relative decrease of sp. ht. in solids predicted by Debye at low temperatures is described. It consists essentially of a specimen in the form of a metal plate suspended in an unsilvered Dewar flask. A condensing lens focuses the radiation of an arc lamp on the specimen and the consequent rise in temperature is detected by noting the rate of drift of a galvanometer connected in series with a copper-constantan thermocouple attached to the specimen. After correction for the difference in e.m.f. per deg. change in temperature of the thermocouple and difference in radiation rates at room temperature and liquid-air temperatures, the relative sp. hts. are given by the relative galvanometer drifts at the two temperatures. Data are given for Ni, Cu and Pb. G. P. H.

CONDUCTION.

1600. Nomographs for thermal conductivities of gases and vapours. D. S. Davis. *Industr. Engng Chem.*, **33,** *pp.* 675–678, *May*, 1941.

DILATATION.

1601. Volume change on mixing gases. A. E. Markham and K. A. Kobe. *J. Chem. Phys.*, **9,** *pp.* 438–439, *May*, 1941.

1602. Comparative tests of chemical glassware. E. Wichers, A. N. Finn and W. S. Clabaugh. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 537–556, *June*, 1941.—This paper describes the results of comparative tests of 4 brands of chemical glassware: Tamworth-Glasbake, Kimble No. N51a, chemical Pyrex, and Vycor (Corning Glass Works' 96% silica glass No. 790). The wares were compared with respect to resistance to acid, alkaline, and nearly neutral reagents, and resistance to thermal and mechanical shock. The chemical composition and the thermal expansivity of each glass were also determined. Authors.

FUSION AND SOLIDIFICATION.

1603. Freezing temperatures of high-purity iron and of some steels. W. F. Roeser and H. T. Wensel. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 273–287, *April*, 1941.—The freezing temperature of high-purity iron (99·99% +) in an atmosphere of He was measured with an optical pyrometer and found to be 1 539° ± 1°C. The same samples were found to freeze 1 deg. lower in an atmosphere of H. In addition, the initial freezing temperatures in an atmosphere of He of some irons of lesser purity, and of some steels, were measured to determine the effects of various impurities and alloying elements. The results of measurements on 23 samples of irons and steels, together with the chemical analyses, are reported. The f.p. depressions of the various elements are listed in a table which may be used to calculate the initial freezing temperatures (liquidus points) of iron containing many combinations of 17 elements, which include all those generally found in commercial irons and steels. The samples containing less than 0·1% of impurities were melted in Be oxide crucibles and the other samples, in all but 2 cases, were melted in crucibles of Al oxide. Temperatures were determined by means of an optical pyrometer sighted into refractory blackbodies immersed in the freezing metal. Authors.

1604. Determination of f.p. and amounts of impurity in hydrocarbons from freezing and melting curves. B. J. Mair, A. R. Glasgow, Jr.

AND F. D. ROSSINI. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 591–620, *June*, 1941.—Simple time/temperature freezing and melting curves are analysed, and a procedure is outlined for determining from them the freezing point of a given substance and the amount of impurity. The procedure was applied to a number of different known solutions of hydrocarbons ranging from 0·006 to 0·115 mole fraction in conc. of solute. For the systems examined it was found that the values for the f.p. of a given substance obtained from both freezing and melting curves were always in accord within their respective limits of uncertainty, and that the estimated amount of impurity was in error by not more than about 10% of itself, on the average. AUTHORS.

TEMPERATURE.

*****1605. Method of producing He temperatures without using liquid hydrogen.** K. SEILER. *Ann Phys., Lpz.*, **39,** 2, *pp.* 129–163, *Feb.*, 1941. *In German.*—After a brief survey of the methods employed the author gives considerations and calculations leading to the design of a simple apparatus for the continuous production of He temperatures. Details are included of its construction and operation, as well as of the most important auxiliary apparatus and instruments used, together with results of measurements. The He is expanded by throttling in a combined counterflow liquefier, the first half of which is in thermal connection with a counterflow hydrogen liquefier fed from hydrogen cylinders. In this manner the He is cooled below its inversion temperature and the hydrogen liquefied only in that part where it serves to pre-cool the He. In addition, only so much of the hydrogen is liquefied as is necessary for the He liquefaction. Built-in throttle valves form a feature of the apparatus. The construction of a special circulator is also described. It is shown how the yield of such a liquefier can be simply measured. H. G. S.

*****1606. Precision cryostat for —35° to +25°C.** E. E. ROPER. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 257–259, *April* 15, 1941.—Descriptions are given of improvements which have been made in a cryostat (*Industr. Engng Chem.*, **12,** *p.* 113, 1940), which continuously maintains temperatures to within a few thousandths of a deg. over the range – 35° to 25°C. The electrical circuit has been altered and a new valve for the expansion of the refrigerant has been designed. R. W. P.

*****1607. The principles of automatic temperature control.** M. J. GARTSIDE. *Engineer, Lond.*, **171,** *pp.* 324–326, *May* 16, 1941. *Paper read before the Manchester Assoc. Engrs.*—A general account of the basic principles of temperature control, and of the design and operation of thermostat units. Suggestions are made regarding the types of instrument best suited for use under various conditions. R. W. P.

See also Abstract 1599.

THERMOCHEMISTRY.

1608. The thermal reaction between H and O. III. The temperature coefficient of the steady thermal reaction. O. OLDENBERG AND H. S. SOMMERS, JR. *J. Chem. Phys.*, **9,** *pp.* 432–437, *May*, 1941.—The thermal combination of H and O, investigated in various vessels, follows the Arrhenius law over a considerable temperature range, in which, according to Hinshelwood, a chain reaction in the gas phase, broken at the wall, must be assumed. It is concluded that in this temperature range the chains are not branched. [See Abstr. 625 (1941)]. AUTHORS.

1609. Dissociation of SO_2Cl_2. H. W. THOMPSON. *Trans. Faraday Soc.*, **37,** *pp.* 340–343, *July*, 1941.—The known molecular data have been used to calculate statistically the free energy of SO_2Cl_2 and, combining the results with the known free energies of SO_2 and Cl_2, the equilibrium constants for the dissociation of this substance have been obtained. The calculated values do not agree very well with those measured. Reasons for the discrepancy are discussed. It is concluded that a further study of the equilibrium is desirable. AUTHOR.

1610. Free energy of methyl cyanide and equilibrium constants of some related reactions. H. W. THOMPSON. *Trans. Faraday Soc.*, **37,** *pp.* 344–352, *July*, 1941.—The thermodynamic functions of methyl cyanide are calculated statistically from the known moments of inertia and molecular vibration frequencies. Certain gaseous equilibria involving this substance are discussed. In the latter connection the thermodynamic functions of methane, ethylene, ethane, cyanogen and ammonia, are calculated, using the most recent molecular data available. AUTHOR.

1611. Computation of intensity distribution in the image of the cone of a flame. H. J. HÜBNER AND H. KLÄUKENS. *Ann. Phys., Lpz.*, **39,** 1, *pp.* 33–50, *Jan.*, 1941. *In German.*—The object of the investigation is to determine whether the true thickness of the luminous zone in the cone of a flame is directly measurable from its optical image. For this purpose the intensity distribution in the optical image of a luminous hollow cylinder is computed with a distribution of the luminous centres defined on certain assumptions. The following results are obtained: (1) No exact measurement of the true thickness of the luminous zone is possible from image measurements, but an evaluation can be made. (2) The shape of the intensity distribution curve depends upon the distribution of the luminous centres in the luminous zone and upon the lens aperture and luminous layer absorption. (3) The true thickness of the luminous zone would appear possible for determination from measurements of the intensity distribution. In this connection further research is in progress. H. G. S.

THERMODYNAMICS.

1612. Second virial coefficients of polar gases. W. H. Stockmayer. *J. Chem. Phys.*, **9**, *pp.* 398–402, *May*, 1941.—An equation is given for the classical second virial coefficient of a polar gas in terms of the parameters appearing in an intermolecular potential energy which includes London and dipole attraction and inverse-power repulsion. The equation is fitted to the data for H_2O and NH_3 with allowance for the small quantum correction, and the derived values of the London constant are in good accord with theoretical estimates. The defects of the model and its relation to the concept of the H bond are discussed. Author.

1613. Theory of acid strength. Temperature effect. J. L. Magee, T. Ri and H. Eyring. *J. Chem. Phys.*, **9**, *pp.* 419–427, *May*, 1941.

1614. Constants of the Beattie-Bridgeman equation. J. Corner. *Trans. Faraday Soc.*, **37**, *pp.* 358–361, *July*, 1941.—It is shown that the third virial coefficients calculated by de Boer and Michels can be used to interpret the constants *a* and *b* of the Beattie-Bridgeman equation. Author.

1615. The "ideal" vapour. C. Eichelberg. *Schweiz. Arch. angew. Wiss. Techn.*, **7**, *pp.* 69–72, *March*, 1941. *In German.*—An account of a thesis by Leib. The relation $\pi/R\theta = pv/RT = (\Theta_0/\Theta)^{1/a}/\{e^{(\theta_0/\theta)^{1/a}} - 1\} = x/(e^x - 1)$ is obtained, where $a = 2/f$, f being the number of degrees of freedom, $\pi = pv^{a+1}$, $\Theta = Tv^a$ and $x = \vartheta_0/\vartheta$ where $\vartheta = T^{1/a}_v$. Using $R = 47{\cdot}06$, $a = 1/3$ and $\Theta_0 = 136{\cdot}5$, a curve is obtained which represents the properties of water vapour up to 300 atm. Subsequently it is shown possible to represent the data for H_2O, NH_3 and CO_2 by means of the single curve $pv/RT = 1 - 1/\vartheta_{red} + 1/3\vartheta^2_{red}$, where $\vartheta_{red} = \vartheta/\vartheta_{crit.\ pt.}$ R. W. P.

1616. Slopes of *pv* isotherms of He, Ne, A, H_2, N_2 and O_2, at 0°C. C. S. Cragoe. *Bur. Stand. J. Res. Wash.*, **26**, *pp.* 495–536, *June*, 1941.—The change of *pv* with pressure or density at const. temperature and low pressures is treated as a characteristic physical quantity. Various methods of determining this quantity from available experimental data for several gases, including He, Ne, A, H_2, N_2 and O_2, are examined with special reference to the reliability of the values at 0°C. Reliable values for these quantities are important for many purposes, such as correcting temperatures measured by means of gas thermometers to the thermodynamic scale and in the derivation of the absolute temperature of the ice point. Author.

1617. Thermodynamics of acid/base equilibria. D. H. Everett and W. F. K. Wynne-Jones. *Trans. Faraday Soc.*, **37**, *pp.* 373–375, *July*, 1941.—[*See* Abstr. 1649 (1941)].

1618. Liquid/vapour equilibrium relations in binary systems. W. B. Kay. *Industr. Engng Chem.*, **33**, *pp.* 590–594, *May*, 1941.—The *P-V-T-x* relations at the liquid- and vapour-phase boundaries in the *n*-butane-*n*-heptane system were worked out from measurements on a series of mixtures varying in composition from pure *n*-butane to pure *n*-heptane. *T*/*x* diagrams of the co-existing liquid and vapour at constant pressure were constructed, from which data were obtained for calculating the phase-equilibrium constants. Information on the effect of the physical properties of the mixture on the phase-equilibrium constants is given by a comparison of the constants for *n*-butane dissolved in ethane and in *n*-heptane, and of those for *n*-heptane dissolved in ethane and in *n*-butane. Author.

1619. Partition function for normal liquids. J. Walter and H. Eyring. *J. Chem. Phys.*, **9**, *pp.* 393–396, *May*, 1941.—A theory of liquids designed to account for rate as well as thermodynamic properties is given. By considering the molecules of the liquid to be distributed at random, among solid-like and gas-like equilibrium positions, where the introduction of a new equilibrium position requires a volume increase of about $\frac{1}{8}$ of the molecular volume, it is possible to derive an explicit partition function for liquids. The model embodies the features previously used in the theory of viscosity and diffusion. The thermodynamic properties of argon, nitrogen and benzene, are calculated and compared with experiment. Authors.

1620. Thermodynamic properties of phosphorus, phosphine and some phosphorus halides. D. P. Stevenson and D. M. Yost. *J. Chem. Phys.*, **9**, *pp.* 403–408, *May*, 1941.—A critical study of the equilibrium and molecular data for phosphorus and some of its compounds has been made and is described. The data are used to calculate the entropies and free energies of the substances considered. Authors.

1621. Reduction of MgO by W in vacuum. G. E. Moore. *J. Chem. Phys.*, **9**, *pp.* 427–431, *May*, 1941.

See also Abstracts 1420, 1584.

VAPORIZATION AND CONDENSATION.

1622. The boiling-point elevation. IV. KBr in Water. G. C. JOHNSON AND R. P. SMITH. *J. Amer. Chem. Soc.*, **63,** *pp.* 1351–1353, *May*, 1941. —B.p. elevations of solutions of KBr in water are determined to 5·0 molal over the range 60°–100°C. Partial molal free energies are calculated from these values. The method of calculating activity and osmotic coefficients is indicated. AUTHORS.

See also Abstract 1387.

ACOUSTICS.

1623. Production of waves by sudden release of a spherical distribution of compressed air in the atmosphere. J. J. UNWIN. *Proc. Roy. Soc. A*, **178,** *pp.* 153–170, *June* 12, 1941.—An attempt is made to develop a method for dealing with solutions of problems connected with the production of waves by spherical concentrations of compressed air. Starting from the general equations for 3-dimensional spherically symmetrical flow in a homogeneous compressible medium having constant entropy everywhere, a process has been devised to apply step-by-step calculations over small intervals of time to investigate the general features of such a motion. A complete solution is worked out for a not very intense initial distribution of pressure, and various indirect checks indicate that the results are reasonably accurate. As distinct from plane or spherical sound wave theory, it is found that a train of waves passes away from the centre of disturbance, the amplitudes and wavelengths falling off from wave to wave. Furthermore, as distinct from finite-amplitude plane-wave theory which shows that any wave must eventually become a shock wave, the waves obtained in the finite-amplitude spherical-wave case show no indication of becoming shock waves and, indeed, show towards the closing stages of the calculation a similarity to sound-wave propagation. The method is applicable to any spherically symmetrical motion up to such a time as the formation of a shock wave takes place and then fails owing to the assumption of constant entropy. AUTHOR.

1624. Mode of vibration of a clarinet reed. C. S. MCGINNIS AND C. GALLAGHER. *J. Acoust. Soc. Amer.*, **12,** *pp.* 529–532, *April*, 1941.—Theoretical explanations of the action of the vibrating clarinet reed have been based upon the assumption of the partial closing of the aperture under the reed. This assumption is not supported by experimental evidence. The motion of the reed was observed stroboscopically, with the tone produced by an artificial embouchure. The actual frequency of the reed is determined and other details in the model of vibration observed. AUTHORS.

1625. Propagation of sound in cylindrical tubes. N. ROCHESTER. *J. Acoust. Soc. Amer.*, **12,** *pp.* 511–513, *April*, 1941.—Formulae are developed for the calculation of the attenuation factor for the first mode ("plane" waves), and these formulae take into account both the resistive and the reactive components of the tube wall impedance. The nature of the higher modes of sound propagation in the tube is illustrated. AUTHOR.

1626. Absorption of h.f. sound waves in gases. H. H. KELLER. *Phys. Z.*, **41,** 16, *Aug.* 15, 1940. *In German.*—The method used by Petersen to measure the absorption of supersonic waves in gases has been further developed. In these measurements a monochromatic, parallel light beam is diffracted by inhomogeneities in density of the gas which are produced by sound waves travelling through it. The decrease in sound intensity with distance from the source produces a change in the distribution of the light on the photographic plate in the first order. Photometric measurements can therefore be used to determine the absorption coefficient. A classical theory of absorption assumes that the energy absorbed from the sound wave is distributed among the translational degrees of freedom. Measurements of the absorption coefficient as a function of the pressure of the gas were made in A, N, NH_3, CO_2, and CO_2 plus 8% H, at a frequency of 4 Mc./s. A theoretical relation was derived which enabled the author to determine the absorption coefficient for these substances as a function of the frequency for atmospheric pressure. This was checked against the results predicted by the classical theory. For A the experimental results agree with those predicted by the theory. This is taken to be a check on the experimental method and on the way in which the results are interpreted. The absorption coefficients of the other substances are larger than those predicted by the theory. This is taken to mean that in these molecules some of the energy absorbed from the sound wave is distributed among the rotational degrees of freedom. Thus, NH_3 has a higher absorption coefficient than N because it requires higher energies to excite its rotational states than does N. Hence NH_3 should have a longer relaxation time. G. P. H.

1627. Methods for determining sound transmission loss in the field. A. LONDON. *Bur. Stand. J. Res. Wash.*, **26,** *pp.* 419–453, *May*, 1941.—In the customary method of determining the transmission loss of a wall or floor partition it is necessary to measure the difference in sound levels existing in 2 rooms which have the partition as a separating wall or floor. Also the ratio A_2/S, where A_2 is the total sound absorption of the receiving room and S the transmitting area of the partition, must be known. Difficulties are experienced in field measurements because of the non-uniformity of sound levels in the test rooms and an uncertain knowledge of A_2. Two new methods which eliminate these difficulties are described. In both of these methods the sound level on the quiet side is measured at the panel face, in the one method with a pressure microphone and in the other with a pressure gradient (ribbon) microphone. In the latter method the transmission loss is independent of the value of A_2/S if the panel face has little sound-absorptive value, while in the former it is possible, in most cases, to eliminate the necessity of measuring A_2 by determining in addition the average sound level in the receiving room. Also, the possibility of using the ribbon microphone as a radiation pick-up is indicated. AUTHOR.

1628. Sound absorption in mixtures of monatomic gases. M. KOHLER. *Ann. Phys., Lpz.*, **39**, 3, *pp.* 209–225, *March*, 1941. *In German.*—The influence of ordinary diffusion and thermal diffusion on sound absorption in monatomic gases is examined by the use of the Enskog equations. On the basis of the kinetic gas theory the equations of motion are derived for the monatomic gas mixture. Nine independent equations are obtained for the 9 unknowns u_1, v_1, w_1, u_2, v_2, w_2; ρ_1 and ρ_2; and T. The propagation of density waves of infinitely small amplitude is considered. The 3 new terms due to diffusion which occur depend on frequency and pressure in the same way as the Kirchhoff terms arising from friction and heat conduction, and are fully discussed. The first term is due to the effect of ordinary diffusion and is proportional to the diffusion coefficient D_{12}, to $(M_2-M_1)^2/M^2{}_0(M = \text{mol. wt.})$, to the ratio c_p/c_v of the sp. hts. and to the product c_1c_2 of the mol. concentrations. The second is due to thermal diffusion and is proportional to $(c_p/c_v) - 1$, to c_1c_2, to $(M_2-M_1)/M_0$ and to a coefficient ν'_{12} which determines the thermal diffusion. The third is occasioned by the increased heat conduction due to thermal diffusion. The possibility of determining thermal-diffusion coefficients from measurements of sound absorption in gas mixtures is mentioned. H. G. S.

1629. Dependence of the speed of sound on the concentration in a mixture of dipolar and non-dipolar liquids. K. SACHER. *Phys. Z.*, **41**, *pp.* 360–362, *Aug.* 1, 1940. *In German.*—In mixtures of a dipolar liquid (C_2H_5OH) and a non-dipolar liquid (CCl_4), the orientation polarization, the heat of mixture and the density exhibit anomalies at molar concentration 0·04 of the dipolar component. These phenomena are explicable on the assumption that at this concentration the dipolar molecules form double molecules with quadrupole moment. The author measured the speed of sound in the given mixture in the expectation of finding similar irregularity. Bachem's method was used. [Abstr. 4505 (1936)]. A quartz oscillator and an amplifier set up a system of supersonic standing waves (5 Mc./s.) in the liquid mixture by reflection. The nodes and loops of the system were characterized by variation in density and optical index of refraction and could be seen with a microscope if illuminated as in Töpler's "Schlieren" method. From the wavelength thus measured, and the known frequency of the supersonic oscillator, the speed of sound could be computed with relative precision 0·03%, absolute precision 0·14%. The adiabatic compressibility, computed from the speed of sound and the density, increased steadily with increasing concentration of alcohol. G. P. H

1630. Supersonic absorption in liquids measured optically. A. LINDBERG. *Phys. Z.*, **41**, *pp.* 457–467, *Oct.* 15, 1940. *In German.*—The optical method of measuring supersonic absorption in liquids by the diffraction of light by the supersonic waves, given originally for ideal sound fields by Grobe [Abstr. 2535 (1938)], is improved by the author to render it suitable in the case of actual sound fields. The applicability of this improved method is tested and established by absorption measurements in benzol and methyl alcohol at high frequencies, and in 2 tables the results are compared with the values obtained by other investigators. The accuracy of measurement is discussed and a limit assigned to the method. The possibility of an extension of this limit is also indicated. Full details are included of the optical arrangement, the essential features of which were indicated by Petersen [Abstr. 1896 (1940)], the h.f. transmitter and frequency meter used, and the photographic process. H. G. S.

∗1631. Objective noise-meter reading in phons for sustained noises, with special reference to engineering plant. A. J. KING, R. W. GUELKE, C. R. MAGUIRE AND R. A. SCOTT. *J. Instn Elect. Engrs*, **88**, *Part II*, *pp.* 163–178; *Disc.*, 179–182, *June*, 1941. [Abstr. 1127 B (1941)].

∗1632. The solovox. F. D. MERRILL, JR. *Electronics*, **14**, *pp.* 30–32, *March*, 1941.—In this Hammond instrument a single a.f. master oscillator feeds into a series of frequency-dividing circuits, the frequencies varying according to the key depressed. In this way, with 3 octaves of piano keys, 6 octaves of pitch are made available with tablet switches for control of tone. The instrument is easily fitted to a piano so that solo passages played on the solovox with the right hand may be accompanied on the piano with the left. Block diagrams of the unit connections and verbal descriptions of the circuits are given. J. P. A.

See also Abstracts 1463, 1564.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

1633. Solution of general a.c. network. S. Noda. *Mem. Ryoj. Coll. Engng*, **13,** *pp.* 289–305, *Dec.*, 1940.—Taking a network of n linear conductors which meet at p junction points the general equations for the steady state are given and a general solution obtained. This solution is simplified by consideration of the closed circuits in the network and by the introduction of virtual currents which are termed circuital currents. A. W.

*** 1634. Measurement of phase angle at high frequency.** W. Holzmüller. *Phys. Z.*, **41,** *pp.* 356–360, *Aug.* 1, 1940. *In German.*—A h.f. bridge is described for measurement of the temperature-dependence of dielectric loss in highly polymeric organic solids. The bridge is energized by a 2-valve push-pull oscillator coupled through an intermediate tuned circuit for the elimination of harmonics. As the bridge is designed for frequencies up to 10 Mc./s. low ohmic resistance is very important. The 4 arms of the bridge are the 2 halves of an inductance coil, a standard variable condenser and a condenser whose dielectric is to be tested. Another variable condenser is joined in parallel with the coil for tuning. Resonance is indicated by diode voltmeters in parallel with the standard and unknown condensers. The phase shift introduced by the dielectric loss which is to be measured is not balanced out; instead, the residual voltage across the diagonal of the bridge is measured by a triode voltmeter. This method permits simplification of the circuit and faster measurements. The bridge yields the tangent of the phase angle with precision better than 10^{-4}. G. P. H.

CONDUCTION AND DISCHARGE IN GASES.

1635. Some characteristics of hollow-cathode discharge tubes. C. C. Van Voorhis and A. G. Shenstone. *Rev. Sci. Instrum.*, **12,** *pp.* 257–261, *May*, 1941.—A study of the characteristic effects of the inert gas, and of variations in the dimensions of the cathode, on the min. pressure at which the Schuler discharge may be started and maintained. Partially closing the open end of the cathode was found to have a very beneficial effect. An interesting example of rotating anode spots, observed incidentally, is also described. Authors.

1636. Electrometric measurement of ionization currents. R. Jaeger. *Arch. techn. Messen, No.* 103, *V*3211–1, *Jan.*, 1940. *In German.* [See Abstr. 1002 B (1941)].

See also Abstract 1577.

CONDUCTION IN SOLIDS AND LIQUIDS.

1637. Galvanomagnetic investigation of the mechanism of electrical conduction in Ba. E. Justi and J. Kramer. *Phys. Z.*, **41,** 8, *April* 15, 1940. *In German.*—The isotropic free-electron gas theory of the increase of resistance of a metal in a magnetic field had to be abandoned because of the discovery of the anisotropy of this effect. Instead, a theory involving the interaction of the electron with the metallic lattice had to be substituted. In the case of a divalent cubic body centred lattice, Kohler's wave-mechanical theory was verified by the experiments on tungsten crystals by Justi and Scheffers. However, the only metal for which the theory holds strictly is Ba. This paper is concerned with measurements of the electrical resistance of Ba, of various purities, between temperatures of 1·85° and 273°K., and in transverse magnetic fields up to 35 000 gauss. A special technique for making contact with the Ba increased the accuracy of the experiments greatly. In the absence of a magnetic field the resistance at low temperatures falls more slowly than would be expected from either a T^4 or a T^5 law. Furthermore, deviations from the Nernst-Mathiessen law are observed. In a magnetic field the resistance varies approx. as H^2, and in a reduced Kohler diagram all observed increases in resistance, $\frac{\Delta\rho(H,T)}{\rho(H=0,T)} = f\left(\frac{H}{r}\right)$, are approx. quadratic in H/r, (r is the reduced ratio of resistance at T°K. to that at a characteristic temperature θ). No indication of saturation is observed anywhere. If one uses the value $\theta = 116$°K., obtained from Lindemann's formula, and makes a Kohler plot for Ba, it is found that Ba shows a greater increase of resistance than any other cubic metal for the same value of H/r. To this extent the consequences of the theory of Kohler for the Ba type of mechanism are confirmed. The deviations from the Nernst-Mathiessen and Kohler rules can be explained by the divalency of Ba. G. P. H.

1638. Galvanomagnetic investigation of mechanism of electrical conduction in single crystals of Cd. E. Justi, J. Kramer and R. Schulze. *Phys. Z.*, **41**, *pp.* 308–325, *July* 1 *and* 15, 1940. *In German.*—Measurements were undertaken on the Cd single crystals whose electrical and thermal resistance and elastic data had been tested by Grüneisen and Goens. Using field intensities up to 37000 gauss in the temperature range from 273° to 4·22°K., about 7 orders of magnitude of resistance change (from 0·04% to 600000%) were observed in a transverse magnetic field. The normal resistance ($H = 0$) does not vary with T^4 or T^5, but with $T^{2.5}$, so that it is not possible to compute a θ_D value by Grüneisen's formula. The resistance change was measured for 2 orientations, with the axis of the rod parallel or perpendicular to the principal hexagonal axis. The resistance changes were measured as functions of temperature, of the residual resistance, of the crystallographic orientation and of the field strength. From these results it follows, for example, that the resistance increase of Cd_{11} is almost isotropic and is almost independent of the angle between the 3-fold subordinate axes and the field direction. On the other hand, the resistance change of Cd_1 is strongly anisotropic even at 273°C. with an anisotropy factor $a=(\Delta\rho_{\max}-\Delta\rho_{\min})/\Delta\rho_{\mathrm{av.}}=1{\cdot}77$, which decreases notably with falling temperature down to 20°K., and then rises again. At 4·22°K. and 37000 gauss $\Delta\rho_{\max}$ and $\Delta\rho_{\min}$ are in the ratio 24:1. The relative resistance change $\Delta\rho_{H,T}/\rho_{H-0,T}$ for a given crystal orientation is according to Kohler's rule. For large and small values of H/r_T ($r_T=R_T/R_{273}$) it increases approx. quadratically, for intermediate values more slowly. The anisotropy factor increases after a small deformation and increase in residual resistance. This phenomenon, together with the nearly quadratic increase in resistance in the He temperature region and the anisotropy min. at medium low temperatures, was explained by a concept of mutually concurrent anisotropy sources, one of which was identified with a speed-of-sound anisotropy, the other with the binding anisotropy of the electrons. In a reduced Kohler diagram the resistance increase of Cd averaged over all azimuths is compared with that of related metals in the periodic system. In accordance with the type theory of mechanism of conduction, the curves for Cd, Be, Mg and Zn lie close together and show, as in the case of the Ba class, unlimited increase in resistance with H/r_T. It is notable that the curves of the hexagonal metals appear to be arranged in order of increasing c/a ratio, so that at a given H/r_T value Cd has the greatest resistance increase of all metals.

G. P. H.

∗1639. Photo-electric voltage compensation. F. Ender. *Phys. Z.*, **41**, 11–12, *June* 15, 1940. *In German.*—An analysis of the circuit proposed by Wulff [Abstr. 3302 (1936)] for the measurement of e.m.f. in such a manner that photo-electric compensation is made for errors produced by internal resistance of the unknown source of voltage. The author concludes that the circuit is no more effective than an ordinary millivoltmeter due to inadequate compensation. G. P. H.

1640. Electron distribution in the Nichols experiment. F. Wolf. *Ann. Phys., Lpz.*, **39**, 2, *pp.* 164–168, *Feb.*, 1941. *In German.*—The distribution of conduction electrons under the action of centrifugal force in the Nichols experiment [Abstr. 1892 (1906)] is discussed in conjunction with the work of G. Bonetto for the case of the rotating body consisting of a metal cylinder of unlimited length. An electron concentration occurs only within a layer of a thickness of a few atomic diameters immediately beneath the surface of the cylinder, whereas over the rest of the body there is a corresponding spatial, practically constant, reduction of electrons. While in the case of the metal cylinder the charge is quantitatively very small, from general considerations a considerably greater electron concentration is to be expected near the periphery of a metal disc having a thickness small in comparison with its radius, and should be realizable electrometrically. H. G. S.

1641. Reflection method of measuring optical and electrical constants at u.h. radio frequencies. L. S. Palmer and G. R. Forrester. *Proc. Phys. Soc., Lond.*, **53**, *pp.* 479–489, *July*, 1941. [Abstr. 1004 B (1941)].

1642. Materials for standard resistances. A. Schulze. *Z. techn. Phys.*, **21**, 6, *pp.* 117–128, 1940. *In German.*—This article reports the experiences of the Reichsanstalt. The substances are mainly Cu-Mn alloys, especially manganine aged by a new process at 400°C., and other alloys of the same metals containing Al (isabellin, novoconstant, therlo). Except the last one, all have shown over a period of 3 years of observations that they were suited as materials for standard resistances. This is also true of Au-Cr alloys. All these substances have a very small temperature coefficient, due to a special heat treatment.

J. J. W.

1643. Ag alloys as resistance materials. A. Schulze. *Phys. Z.*, **42**, *pp.* 6–13, *Jan.* 1, 1941.

In German.—The electrical and mechanical properties of the 3 Ag alloys known by the trade names NBW108 (82% Ag, 10% Mn, 8% Sn), NBW139 (78% Ag, 13% Mn, 9% Sn) and NBW173 (80% Ag, 17% Mn, 3% Sn) are investigated. The results show the marked dependence of these alloys on heat treatment. In the cold-worked state they have relatively large negative temperature coefficients of resistance, which by suitable ageing can be brought to a zero value. Their specific resistances in the cold-worked state at room temperatures are: NBW108, 0·55 Ω mm^2./m. falling to 0·51 and 0·44 after ageing at 175° and 300°C. respectively; NBW139, 0·61 Ω mm^2./m. dropping to 0·57 after ageing at 195°C.; NBW173, 0·58 Ω mm.^{2}/m., becoming 0·46 on ageing at 270°C. Their thermo-e.m.f.'s to Cu are very small: NBW108, $+ 0{\cdot}5\ \mu$V/deg. C.; NBW139, $- 0{\cdot}2\ \mu$V/deg. C.; NBW173, $+ 2\ \mu$V/deg. C., all at room temperature. 1 Ω and 10 Ω standards have been made and show practically no secular change of resistance. From mechanical considerations the best alloy for resistance standards is NBW108, NBW173 comes next; NBW139 does not appear suitable owing to its great hardness and brittleness, despite its good electrical features. [*See also* Abstr. 2231 (1940)]. H. G. S.

1644. Blocking layers. W. Schottky. *Schweiz. Arch. angew Wiss. Techn.*, **7**, *pp.* 20–29, *Jan.*, *and pp.* 82–86, *March*, 1941. *In German.* [Abstr. 1044 B (1941)].

See also Abstracts 1395, 1412.

DIELECTRICS AND CAPACITANCE.

1645. Dielectric after-effect phenomena in phosphors. H. Ruffler. *Ann. Phys., Lpz.*, **39**, 3, *pp.* 203–208, *March*, 1941. *In German.*—The present work is concerned with the investigation of the after-effect in CdS-Cu phosphors of varying Cu content both in the unexcited and the excited state at different temperatures. At constant temperature the after-effect diminishes with diminishing metal concentration. Exposure to light causes a considerable increase of the after-charge current, the increase being greater tor lower than for higher metal concentration. Temperature rise magnifies the after-effects. For the unexcited phosphor this magnification is not essentially dependent upon metal content. By the irradiation the influence of temperature on the after-charge current is raised considerably, and the more so the higher the metal concentration. The results are in agreement with the representation of the existence of dipoles of mobility and electric moment dependent in a definite way on the structure and state of excitation of the phosphor. H. G. S.

1646. Electric breakdown of glasses and crystals as a function of temperature. A. von Hippel and R. J. Maurer. *Phys. Rev.*, **59**, *pp.* 820–823, *May* 15, 1941. [Abstr. 997 B (1941)].

1647. Dielectric loss factor and loss index of ceramic materials for alternating voltages of industrial frequency and temperatures between 100° and 500°C. E. F. Richter. *Phys. Z.*, **41**, *pp.* 229–233, *May*, 1940. *In German.*—The loss factor (ratio of resistive to capacitive current), dielectric constant, and loss index (product of loss factor and dielectric constant), are measured for 10 ceramic insulators at a frequency of 50 c./s. as a function of temperature between 100° and 500°C. It is pointed out that, for quite high temperatures, capacitive effects can be neglected since the material behaves like a semi-conductor. For quite low temperatures the resistive current is small, and both the loss factor and the dielectric constant can be measured by bridge methods; the power loss is then proportional to the loss index. For the intermediate temperature range investigated here the material can be represented approx. by a loss-free condenser and an ohmic resistance in parallel, and measurements are made on that basis. Graphs of loss factor, dielectric constant and loss index, against temperature are given. In general, the loss index increases monotonically with temperature, although for one substance (Tempa S) it is nearly constant from 200° to 350°. For one group of materials investigated the loss index increases by a factor of about 1 000 between 100° and 300°, while for another group it is very small below 200° and has increased by a factor 100 at 450°. G. P. H.

See also Abstract 1641.

ELECTROCHEMISTRY.

1648. Metastability of $CdSO_4$ and its effect on e.m.f. of saturated standard cells. G. W. Vinal and L. H. Brickwedde. *Bur. Stand. J. Res. Wash.*, **26**, *pp.* 455–465, *May*, 1941. [Abstr. 995 B (1941)].

1649. Temperature dependence of the ionization constants of monocarboxylic acids. J. F. J, Dippy and H. O. Jenkins. *Trans. Faraday Soc.*, **37**, *pp.* 366–373, *July*, 1941.—[See Abstr. 212 (1940).] A review is made of the data so far recorded for the variation of the ionization constants of monocarboxylic acids with temperature, and the relationships advanced to account for this temperature dependence are discussed critically. It is claimed that the tendency to regard these equations as extrapolation formulae is unjustified and capable of leading to erroneous conclusions. This contention is made the basis of a defence of the present practice of employing thermodynamic ionization-constant data for a fixed temperature and aqueous solution, in preference to other quantities, as a measure of true acid strength. AUTHORS.

1650. Influence of temperature on electrical measurements of ion concentrations. J. FISCHER. *Z. techn. Phys.*, **21,** 8, *pp.* 161–169, 1940. *In German.*—The author derives a formula from Nernst's theory, which shows the influence of temperature on *p*H measurements. Experiments confirm the formula $E_t = E_{to}(1 + \kappa[t - t_o]) + \epsilon\,(t - t_o)$ where E_t and E_{to} are the e.m.f.'s at t and t_o, respectively, and κ and ϵ constants depending on the electrodes used. J. J. W.

1651. Circuit elements and circuits automatically compensating or taking into account the effect of temperature in measurements of ion concentrations. J. FISCHER. *Z. techn. Phys.*, **21,** 8, *pp.* 169–174, 1940. *In German.*—The author describes circuits which can compensate the effects $\kappa(t - t_o)E_o$ and $\epsilon(t\ z\ t_o)$ and analyses these circuits showing that it is possible to eliminate completely the temperature effects by choosing the elements of the circuits properly. The circuits can be used for automatical control of the manufacture of certain products depending on the *p*H. J. J. W.

1652. Activity of glycine in aqueous solutions of KCl, from e.m.f. measurements. R. M. ROBERTS AND J. G. KIRKWOOD. *J. Amer. Chem. Soc.*, **63,** *pp.* 1373–1377, *May*, 1941.—Measurements of e.m.f. at 25°C. were made on 78 concentration cells with transference of the type

$$Ag|AgCl|KCl(m_1)|KCl(m_1),\text{glycine}(m_2)|AgCl|Ag.$$

The dipole moment of the glycine dipolar ion was calculated to be 14·4 Debye units. AUTHORS.

1653. Anodic waves involving electro-oxidation of Hg at the dropping Hg electrode. I. M. KOLTHOFF AND C. S. MILLER. *J. Amer. Chem. Soc.*, **63,** *pp.* 1405–1411, *May*, 1941.—The equation of the anodic waves of thiosulphate, sulphite, hydroxide and thiocyanate ions is given by $\pi = \pi_0' + (RT/2F)\log_e i/(i_d - i)^2$. It is shown that the waves of thiosulphate and sulphite correspond to the formation of a complex ion: $S_2O_3{}^{=} + Hg \rightleftarrows Hg(S_2O_3)_2{}^{=} + 2e$. The waves of hydroxyl and thiocyanate correspond to the formation of undissociated mercuric hydroxide and thiocyanate. Thiosulphate yields a second wave due to an irreversible oxidation. The ½-wave potentials of the above 4 waves change with the diffusion current according to: $\pi_{\frac{1}{2}} = \pi_0'' - (RT/2F)\log_e i_d$. Chloride, bromide and iodide, yield the corresponding mercurous salts on the anodic waves. Films of the insoluble mercurous compounds may interfere with the course of the current/voltage curves. When the film has attained a certain thickness in the case of bromide the drop becomes polarized and a second wave appears. The film effect is eliminated in the case of bromide by addition of a trace of gelatin. The film of mercurous iodide exerts properties at the electrode different from those of the bromide. The effect of the films upon the electrocapillary behaviour of mercury is determined. All the above anions, and also sulphide and cyanide, can be determined polarographically under the proper conditions. AUTHORS.

1654. Electric polarization of carboxylic acids in dilute solutions of non-polar solvents. I. Relation of electric polarization to the association of carboxylic acids in hydrocarbon solvents. H. A. POHL, M. E. HOBBS AND P. M. GROSS. **II. Polarization of heavy acetic acid and of the 3 fluorobenzoic acids in benzene and the anomalous polarization of the dimer.** A. A. MARYOTT, M. E. HOBBS AND P. M. GROSS. *J. Chem. Phys.*, **9,** *pp.* 408–418, *May*, 1941.—The association and polar character of various carboxylic acids are studied in the solvents benzene and heptane by means of measurements of the electric polarization in very dilute solutions. The data are analysed by assuming an equilibrium between dimers and monomers of the acid molecules. A rather large anomalous contribution to the polarization of the dimer is found and possible origins of this are briefly considered.—The electric polarizations of acetic acid-*d* and *o*- *m*- and *p*-fluorobenzoic acids are determined in benzene solution at concentrations ranging from approx. 10^{-5} to 10^{-2} mole fraction of solute. On the assumption of a monomer-dimer equilibrium, the polarization of the monomer and of the dimer molecules and the equilibrium constant are calculated. The unexpectedly high polarization of the dimer is best interpreted on the basis of the assumption of an atomic polarization of about 20 cm.^{3} AUTHORS.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

1655. Is the Dirac theory of the positron Lorentz-invariant? H. HÖNL. *Phys. Z.*, **42,** *pp.* 19–23, *Jan.* 1, 1941. *In German.*—The author's examination of the problem leads him to the following two alternatives. Either individuality must be conceded to the eigenstates of the vacuum electrons in the Dirac theory; then the formulation of the Dirac theory is relativistically non-invariant—apart from the special case of the impulse distribution dealt with in §2 of the article. In this case the demand for an "absolute" reference system is inevitable. Or the individuality of the vacuum electrons must be discarded and in this way the relativistic invariance saved, i.e. enforced by a new postulate. Avoidance of these radical consequences can only mean acceptance of the Lorentz-invariant impulse distribution for the vacuum electrons $dN_o = N_o(p)dp = 4\pi C' \dfrac{p^2}{\sqrt{(p_o^2 + p^2)}}\,dp$. No attempt is made to decide between these two possibilities. H. G. S.

1656. Consequences of the assumption that heavy elementary particles may have a negative charge. M. Fierz. *Helv. Phys. Acta*, **14,** 2, *pp.* 105–110, 1941. *In German.*—The theory of Heitler to explain the scattering of mesons at heavy particles, in which it is assumed that the masses of particles of charge *e* and 2*e* is about 17 eMV greater than the mass of the proton, is shown to be untenable, as it would require that the neutrons and protons of the nucleus should be partly replaced by negatively charged particles, making the charge of a nucleus of given mass much smaller than it actually is. If heavy particles of charge $-e$ exist, their mass must be at least 55 eMV greater than that of the proton. A. J. M.

1657. Scattering in the pair theory of nuclear forces. J. W. Weinberg. *Phys. Rev.*, **59,** *pp.* 776–780, *May* 15, 1941.—The scattering of particles of spin $\frac{1}{2}$ and mesotronic mass *m* by heavy nuclear constituents is investigated with the pair theory of Critchfield and Teller, in which a nucleus appears as an extended source of mesotrons. A rigorous formula is found for the cross-section by obtaining explicitly the normal co-ordinates of the perturbed mesotron field. When the constants are adjusted to give a model of nuclear forces with approx. the right range and saturation properties, $\sigma \simeq 32\pi (mc^2/E)^4(\hbar/mc)^2$. Although in other models σ may decrease more rapidly with the energy *E*, it is always about 10^{-24} cm.^{2} at low energies, as contrasted with the cross-section of about 10^{-28} cm.^{2} observed for cosmic-ray mesotrons. These results are discussed in relation to other accounts of the pair-field theory. Author.

1658. Scattering, trapping and release, of electrons in NaCl and in mixed crystals of NaCl and AgCl. A. von Hippel and G. M. Lee. *Phys. Rev.*, **59,** *pp.* 824–826, *May* 15, 1941.—The dielectric strength of the alkali-halide crystals decreases steeply with temperature in the higher temperature range. This fact cannot be explained by thermal breakdown, but it points towards a new mechanism which has been investigated in rocksalt and mixed crystals of NaCl and AgCl. The facts observed can be explained by the assumption that the intensity of the electron avalanches is decisively influenced by trapping of secondary electrons in the lattice, and their release by heat vibrations. New spectroscopic evidence for the trapping mechanism is presented. Authors.

1659. Deuteron disintegration by electrons. B. Peters and C. Richman. *Phys. Rev.*, **59,** *pp.* 804–806, *May* 15, 1941.—The cross-section for the disintegration of deuterons by electrons has been calculated. Near the threshold the magnetic cross-section is larger, increasing with the square, while the electric cross-section increases with the cube, of the energy. They become equal at about 600 ekV above the threshold when each has a value of $3{\cdot}5 \times 10^{-31}$ cm.^{2} The disintegration neutrons should be observable from 50 ekV. An experiment of this kind might be used to check the theoretically predicted magnetic disintegration. Authors.

1660. Electron diffraction observations of surface reaction of hydrogen selenide on zinc oxide. M. L. Fuller and C. W. Siller. *J. Appl. Phys.*, **12,** *pp.* 416–419, *May*, 1941.—H_2Se reacts with ZnO to form ZnSe as a coating around the ZnO particles. After approx. $\frac{1}{10}$ of the ZnO is converted to ZnSe by this surface reaction, the resulting coating of ZnSe prevents the continuance of the reaction. Since the effective depth of penetration of electrons under the conditions of electron diffraction is much less than the average dia. of the pigment particles used in this investigation, the electron diffraction photograms necessarily arise largely from the particle surfaces. Authors.

1661. Low-velocity H-ion scattering in H_2, H_2O and NH_3. A. S. Russell, C. M. Fontana and J. H. Simons. *J. Chem. Phys.*, **9,** *pp.* 381–387, *May*, 1941.—Improved technique has enabled more precise measurements to be made of the effective cross-section for scattering of H_2, H_2O and NH_3 for low-velocity protons and of H_2 for low-velocity H_2^+ and H_3^+. From the measurements of proton scattering in H_2 and NH_3 and H_3^+ scattering in H_2, and the use of certain assumptions, the average force laws can be evaluated and the energy of combination estimated in the first two cases. The proton affinities thus calculated for H_2 and NH_3 agree with previous estimates. For H_2^+ in H_2 an evaluation of force law and an estimate of energy of combination cannot be made. Further increase in precision, separation of scattering from neutralization and extension of measurements to lower velocities of ions, is necessary also to evaluate the force law and proton affinity of water. Authors.

1662. Nuclear scattering of rapid electrons in argon. P. Scherrer and W. Zünti. *Helv. Phys. Acta*, **14,** 2, *pp.* 111–129, 1941. *In German.*—The anomalies found in the scattering of rapid electrons at N nuclei are not found with A, but the scattering cross-section agrees satisfactorily with Mott's theory both as regards angular distribution and energy relationships. A. J. M.

1663. Dependence of scattering of rapid electrons at the nitrogen nucleus on energy. W. Bosshard and P. Scherrer. *Helv. Phys. Acta*, **14,** 2, *pp.* 85–104, 1941. *In German.*—The dependence of the scattering of rapid electrons by the N nucleus on the energy of the electrons has been investigated, using a cloud-chamber method. The relationships is anomalous and does not agree with Mott's theory, from which it is concluded that there must be some other interaction between nuclei and electrons in addition to the Coulomb interaction. A. J. M.

1664. Energy distribution of secondary electrons. I. Method of the longitudinal magnetic field. R. KOLLATH. *Ann. Phys., Lpz.*, **39,** 1, *pp.* 59–80, *Jan.*, 1941. *In German.*—The considerations leading the author to the choice of the longitudinal magnetic field method of measuring the energy distribution of secondary electrons are outlined and the conditions examined for the satisfactory carrying-out of the measurements. The technique and apparatus used, particularly the special "analyser," are fully described. Results of measurements on layers of Ta, Mo and Be are given and the effect of annealing the layers on the shape of the distribution curve is discussed. Preliminary measurements on a Cs-Sb photo-layer are included and demonstrate the applicability of the method to the determination of the energy distribution of photo-electrons. The methods employed and the results obtained by various authors since 1925–30 are given in tabular form. H. G. S.

1665. Production of secondary electrons by electrons of energy between 0·7 and 2·6 eMV. G. HORNBECK AND I. HOWELL. *Proc. Amer. Phil. Soc.*, **84,** *pp.* 33–51, *April*, 1941.—The production of secondary electrons in the gas of a cloud chamber is studied, using 190 m. of track. The energies of the secondaries are obtained by measuring their ranges. Thus it is possible to obtain values of the cross-section for production of a secondary with kinetic energy T, greater than some chosen value T_0, but less than $T_p/2$, where T_p is the primary kinetic energy. These may be compared with values calculated from Möller's theory. The results are substantially in agreement with theory. Discrepancies reported by Williams and Terroux can probably be explained on the basis of 2 factors: (1) inclusion of secondaries with ranges so small that it is difficult to obtain their energies; (2) the number of secondaries of high energy is small, which leads to large statistical fluctuations. AUTHORS.

1666. Direct measurement of secondary electron yield from insulators. W. HEIMANN AND K. GEYER. *Elekt. Nachr.-Techn.*, **17,** *pp.* 1–5, *Jan.*, 1940. *In German.* [Abstr. 1166 B (1941)].

***1667. Electronic integrator for counting circuit contacts.** G. W. KENRICK. *Electronics*, **14,** *pp.* 33–35 *and* 74–76, *March*, 1941. [Abstr. 1117 B (1941)].

See also Abstracts 1383, 1386, 1530.

MAGNETISM AND ELECTROMAGNETISM.

1668. Calculation of the torque on a ferromagnetic single crystal in a magnetic field. R. M. BOZORTH AND H. J. WILLIAMS. *Phys. Rev.*, **59,** *pp.* 827–833, *May* 15, 1941.—When a disc cut from a cubic crystal of a ferromagnetic material is placed in a magnetic field parallel to its plane, the torque exerted on the disc by the field generally increases continually with the strength of the field, approaching a finite limit (saturation) in very high fields. An anomaly for one orientation of a crystal of iron-silicon alloy has recently been observed by Tarasov [Abstr. 554 (1940)]. This is confirmed and a similar effect observed for a series of orientations of discs cut parallel to the (110) and (100) planes. As the field strength is increased, the torque passes through a well-defined max. before beginning the final approach to saturation. This anomalous peak is now explained in terms of the domain theory; no new concepts are necessary. A graphical method is described for calculating torque and magnetization curves for any direction of the applied field. Torque curves depend markedly on the demagnetizing factor of the disc and, in many cases, a high demagnetizing factor prevents observation of a max. in the curve torque/field-strength. AUTHOR.

1669. Paramagnetic relaxation and the equilibrium of lattice oscillators. J. H. VAN VLECK. *Phys. Rev.*, **59,** *pp.* 724–729, *May* 1, 1941.—The conventional models of paramagnetic relaxation cannot be used at He temperatures, because the lattice vibrations cannot serve as a thermostat in the way ordinarily supposed. If the quanta exchanged between the spin system and the lattice oscillators are of the order 0·2 cm.$^{-1}$, characteristic of the usual Stark splittings in chrome or iron alum, the spins will be in thermal contact only with oscillators at the l.f. end of the lattice spectrum, of which there are too few to conduct away the surplus spin energy. It is found that this limited band of oscillators is interrupted much more frequently by interactions with the spins than by (*a*) collisions with the walls or (*b*) interplay with other oscillators due to anharmonic terms. Consequently the lattice vibrations in thermal contact with the spin system will be at nearly the spin temperature, and not at that of the He container, as ordinarily supposed. Impurities with abnormally large Stark splittings, of the order 2·0 cm.$^{-1}$, would make a wider band of lattice oscillators available and so would avoid the difficulty of insufficient lattice conductivity, but it is doubtful whether the impurities could be in thermal equilibrium with the great bulk of the paramagnetic ions. AUTHOR.

1670. Single casting magnet cores. E. B. JORDAN. *Rev. Sci. Instrum.*, **12,** *pp.* 261–264, *May*, 1941.—The magnets used in the new University of Illinois mass spectrograph are described. Included is a discussion of the advantages and disadvantages of single-casting cores as compared with the usual built-up multiple-section type of core. Core designs for mass-spectrographic purposes and possible limitations of size are suggested. Plots showing the experimental and theoretical fringing-flux distributions for Armco iron, and also the general stray-field distribution around the larger magnet, are included. AUTHOR.

1671. Magnetostriction of iron in strong magnetic fields. O. RÜDIGER AND H. SCHLECHTWEG. *Ann. Phys., Lpz.*, **39**, 1, *pp*. 1–18, *Jan.*, 1941. *In German.*—A computation is made of the longitudinal effect of magnetostriction in the direction of the field, and especially of the asymptotic behaviour in strong fields and any crystallographic field orientation. Neglecting the magneto-elastic and elastic energy in contrast to the crystal energy, as is usual in the case of iron, the connection is obtained between field strength and direction of magnetization. Comparison with known research on mono-crystals shows the field strengths hitherto utilized to have been too weak for inconsistencies between theory and experiment to be detected. Investigation with a quasi-isotropic polycrystal likewise reveals no discrepancy between experiment and theory for the saturation value and asymptotic behaviour. H. G. S.

See also Abstract 1584.

MEDICAL RADIOLOGY AND ELECTROLOGY.

1672. Physical investigations with 140 kV radiation. L. F. LAMERTON. *Brit. J. Radiol.*, **14**, *pp*. 199–205, *June*, 1941.—The paper relates to physical measurements of radiation excited by apparatus of commercial manufacture intended for therapeutic use, and utilizing half-wave rectified voltages between 60 and 140 kV. Radiation from this generator is applied to the patient's skin via an applicator, and a device is described and illustrated which allows observation of the part of the body to be irradiated, when the applicator has been placed in position. Absorption measurements were made with a Victoreen condenser dosimeter via copper filters. Data and curves are given of dosage rate via air, depth dosage and variation of depth dosage on filtration, and precautions necessary for eliminating errors. Further measurements are detailed with respect to volume distribution and scattering of radiation. B. J. L.

1673. Biological effects of ionizing radiations, G. FAILLA. *J. Appl. Phys.*, **12**, *pp*. 279–295, *April*, 1941.

1674. Inherent radioactivity of human blood and its significance for Ra poisoning. A. KREBS. *Kolloid Z.*, **89**, *pp*. 309–310, *Nov.*, 1939. *In German.*—The activity of normal human blood was investigated by the Geiger counter and found to be about 10^{-12} to 10^{-13} g. Ra equivalent per cm.^{3} The significance of this quantity for the questions of max. dose in Ra therapeutics and of early diagnosis of Ra poisoning is discussed. R. N.

1675. Physical differences between types of penetrating radiation. A. H. COMPTON. *Amer. J. Roentgenol. & Radium Ther.*, **44**, *pp*. 270–275, *Aug.*, 1940. *Abstr. in Radiography*, **7**, *pp*. 69–73, *May*, 1941.—Of the available forms of penetrating radiation only X-rays and neutrons give promise of valuable therapeutic properties. Nothing is to be gained in the case of X-rays by using potentials in excess of 500 kV. Neutrons are of about the same penetrating power as the h.v. X-rays in common use but differ in the type of ionization produced and in their preferred action on hydrogen-containing matter. It may therefore be expected that the two types of radiation should differ in their biological effects, but it is not yet known under what conditions, if any, neutrons are superior to X-rays in their therapeutic action. J. T.

1676. Simple fluoroscopic method of localization. O. M. ALEXANDER. *Radiography*, **7**, *pp*. 65–68, *May*, 1941.—The method depends on carrying out screening in 2 reproducible positions. The screen is in contact with the skin in each case, and the depth at which a foreign body lies below a mark made on the skin at an appropriate point is indicated by a simple locating device. J. T.

OSCILLATIONS AND WAVES.

1677. Coupled radiation fields in the circular cylindrical hollow conductor. H. BUCHHOLZ. *Ann. Phys., Lpz.*, **39**, 2, *pp*. 81–128, *Feb.*, 1941. *In German.*—In this mathematical treatise the radiation field of dipoles within a perfectly conducting cylindrical hollow conductor and having their direction perpendicular to the axis of the conductor is computed. The subject is considered under the headings: (1) The radiation field of the tangential electric dipole. (2) The radiation field of the radial electric dipole. (3) The radiation field of the magnetic dipole. (4) The apparent surface charges and surface currents of the electric dipole perpendicular to the axis in the dipole plane $z = 0$. (5) The apparent surface charges and surface currents of the axial electric dipole in the dipole plane $z = 0$. (6) Some applications to ring-shaped transmitters. In this section the formulae developed in (2) and (3) are applied to the investigation of the radiation properties of (*i*) the circular frame transmitter with constant current amplitude;

(*ii*) the circular frame transmitter with 2 m. standing half-waves; and (*iii*) the circular frame transmitter with travelling wave. H. G. S.

1678. Development in meteorological sounding by radio waves. A. W. Friend. *J. Aero. Sci.*, **7**, *pp.* 347–352, *June*, 1940. [Abstr. 1134 B (1941)].

1679. Further comparisons of meteorological soundings by radio waves with radiosonde data. A. W. Friend. *Bull. Amer. Met. Soc.*, **22**, *pp.* 53–61, *Feb.*, 1941. [Abstr. 1133 B (1941)].

1680. Recent applications of radio to the remote indication of meteorological elements. H. Diamond. *Elect. Engng, N.Y.*, **60**, *pp.* 163–167, *April*, 1941. [Abstr. 1155 B (1941)].

PHOTO-ELECTRICITY.

1681. Photo-electric sensitization of alkali surfaces by electric discharges in water vapour. J. T. Tykociner, J. Kunz and L. P. Garner. *Bull. Ill. Engng Exp. Sta.*, *No.* 325, [34 *pp.*], 1940. —Photo-electric sensitivities of alkali surfaces by discharges in purified H_2 compared with sensitivities produced by discharges in H_2–H_2O and in He–H_2O vapour mixtures showed an increase when intense Balmer lines predominated in the spectrum of the discharge, indicating the presence of H. The essential presence of H_2O vapour indicated that dissociated H_2O vapour might be the source of H and the main factor in the sensitization process. To test this, beams of dissociated H_2O vapour were produced in high vacuum and used for bombarding K surfaces. A gradual increase in photo-electric sensitivity followed by a rapid decrease suggested the formation of a monatomic gas layer, which, by interaction with the alkali surface atoms, set the condition for max. sensitivity. Electric discharges in pure H_2O vapour were then applied to the sensitization of Li, Na, K, Rb and Ce photo-electric tubes. A detailed report with a discussion of results and probable mechanism is given. N. M. B.

See Abstracts 1547, 1639.

PIEZO-ELECTRICITY.

1682. Preparation of piezo-electric quartz plates. F. Butler. *Electronic Engng*, **14**, *pp.* 252–254 *and* 281, *June*, 1941. [Abstr. 1138 B (1941)].

THERMIONICS.

1683. Activation phenomena in thoriated tungsten and thoriated molybdenum. H. Nelting. *Z. techn. Phys.*, **21**, 5, *pp.* 103–110, 1940. *In German.*—The author studies experimentally the activation of thoriated molybdenum filaments by the method used by Langmuir for tungsten. The difference between Mo and W can be explained by assuming that the thorium diffuses to the surface of the filament through cracks or at the borders of the microcrystals. A theory of this effect is given which shows that the behaviour of W and Mo can be described by the same formula if one assumes that the amount of the diffusing to the W surface is independent of time while the diffusing in Mo does depend on time. Practically, thoriated molybdenum is useless compared with tungsten, as at high temperature the thorium evaporates very rapidly from the Mo. J. J. W.

1684. The function of copper in the tungsten-copper-barium cathode. K. Brüning. *Phys. Z.*, **41**, pp. 285–290, *June* 15, 1940. *In German.*—The function of copper in Cu-Ba-W cathodes was studied by determining the rate of evaporation of Cu with and without Ba coatings from the cathode from de-activation curves. It is found that de-activation curves are sensitive to less copper than can be detected by micro-analysis. It is concluded that the Cu and Ba form an alloy of which the W is not a constituent. This alloy clings to W wire better than either of its constituents. The work function of such a cathode is found to be 1·05 V. No discontinuity in work function, such as that reported by Goetz at the melting point of copper, is found as a function of temperature. G. P. H.